Exploring the Nature of Individual Differences in Pragmatics in Infancy

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Thesis Abstract

Individual differences in the development of vocabulary in infancy and childhood are well established. However, little is known about individual differences in early *pragmatic* skill, despite a) the proposed centrality of pragmatics to the development of communication, and b) evidence for adverse consequences across the life course for those with pragmatic difficulties. This thesis sought to address the gap in our understanding of variation in early pragmatic ability. Chapter 3 established individual differences in the naturalistic expression of a range of communicative intentions in a sample of 18-month-olds, as well as in modality of expression and in concurrent expressive and receptive vocabulary. It also aimed to examine the architectural interplay between these behaviours in development and found the frequency of expression of most communicative intentions was correlated with the frequency of expression of most other communicative intentions. Furthermore, they tended to correlate with vocabulary size, suggesting these domains are intricately linked. Chapter 4 found that a series of structured tasks administered in the home and designed to elicit pragmatic responses to referential ambiguity and communicative breakdown, did not relate to the naturalistic expression of communicative intentions in the same way, suggesting that pragmatics is not a heterogenous set of abilities. Chapter 5 tested for associations between the naturalistic expression of communicative intention and a range of socio-economic and environmental variables to better understand the potential influence of infant's familial circumstances, and the input and beliefs of their caregivers. There were significant social gradients in the expression of communication intentions, in the production of vocal-gesture combinations and gaze coordinated acts, and in expressive and receptive vocabulary. Collectively, these findings demonstrate the existence of variation in early pragmatic ability, show that formal and functional aspects of language are closely intertwined early on, and that both are susceptible to environmental influence.

Publications and Presentations

Publications:

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Abstract

The topic of this thesis is the nature of individual differences in pragmatics in early infancy, principally in the expression of a range of communicative intentions at 18 months while the infant is still relatively pre-verbal (despite the emergence of first words at around 12 months). It considers interrelations between the frequency of expression of various communicative intentions in naturalistic settings, and whether there are associations between the intentions and a) the infants' concurrent formal language skill (Chapter 3), b) their performance on various structured social communication tasks based on experimental paradigms (Chapter 4) and c) aspects of the infants' environment (Chapter 5). This introductory Chapter provides the background and motivation for this work across four related sections. Firstly, we explore definitions of pragmatics, zeroing in on one phenomenon in particular, speech acts, which allow us to 'do things' with communication (such as make a request or comment on a novel event) as well as 'say things'. Secondly, we consider previous applications of speech act theory to the development of communication in infancy with particular emphasis on the types, and challenges, of speech act coding schemes and taxonomies. Thirdly, we turn to the importance of individual differences in studies of human behaviours, particularly in language and communication, highlighting a gap in our understanding of individual differences and specifically *pragmatic skills*. Finally, we articulate the research questions for this thesis.

1.2 Defining Pragmatics

That pragmatics is difficult to define is not disputed. As Matthews (2014) highlighted, the question of what pragmatics actually *is* fills multiple chapters of textbooks on the subject (Levinson, 1983; Ninio & Snow, 1996; Ochs & Schieffelin, 1979), and more recently inspired a whole book ''Defining Pragmatics' (Ariel, 2010). However, there is at least relative agreement on a broad and fundamental characterisation of pragmatics as the ability to *use* language appropriately in interpersonal contexts (Levinson, 1983; Mey, 1998). The scope of pragmatics covers not the formal aspects of speech (phonology, morphology, semantics, and syntax), but the functional ways that we use language in everyday interaction with others. Subsequently, the field is often accused of being a loosely connected "list of topics" rather than a cohesive set of abilities (Ariel, 2010, p. 16), and most pragmatic texts admit a broad range of phenomena under the pragmatics umbrella, such as deixis, implicature, presupposition, speech acts, turn taking, humour, irony, narrative and paralinguistic cues.

Formal linguists have tended to regard formal levels of the linguistic system (i.e., syntax) as discrete groups of skills, governable by formal rules and quantitatively analysable (Scott-Phillips, 2017). In contrast, they view pragmatics as peripheral, extralinguistic (Chomsky, 1990), and residual (i.e., what is leftover once other levels are taken away; see Gazdar, 1979; Bar-Hillel, 1971). However, *functional* or usage-based accounts of communication reject this position in favour of a pragmatics-first approach, in which pragmatics is shifted from the periphery to the centre of theories of communication (Scott-Phillips, 2017). For this group of researchers, pragmatics is seen as logically antecedent to formal aspects of language in a) the success of our everyday interactions (Bates & MacWhinney, 1990; Bates et al., 1982; Levinson, 2019), b) the development of human communication in phylogeny (Moore, 2017; Scott-Phillips, 2015; Tomasello, 2010), and most pertinent to this thesis, c) language acquisition in ontogeny (Bates, 1976; Bruner, 1975). The next sections hone in on one pragmatic phenomena in particular, the speech act, the development of which is the principal focus of this thesis. Broadly defined as the intentions underlying what we say, speech acts are considered an integral pragmatic ability and potentially the most widely researched pragmatic topic (Levinson, 1983). We will now review the theory behind speech acts and move on to chart how these develop and are in place in infancy *before* we utter our first words (Bates et al., 1975).

1.2 Communicating to Do Things: Speech Acts

Arguably, the principal functions of human communication are to a) connect with others to do things, and b) do things to connect with others, and by "do things", this could be as simple as directing, following and sharing in others' attention towards entities in the world, or as profound and impactful as pronouncing marriage or declaring war. As adults, we achieve this by combining the conventional linguistic symbols of our communities to construct meaning, but in doing so, our utterances simultaneously "perform specific actions" (Levinson, 1983, p. 236). These are termed speech acts and they are defined as the various intentions and propositional goals underlying our communicative behaviours. Speech act analysis originated in the lectures of Austin (1962), and his aim, (in line with other contemporaries taking a pragmatics-first approach to language, i.e., Grice (1957) and Wittgenstein (1953)), was to challenge the prevailing logical positivist view that meaning in communication must have a truth-conditional value. Put simply, utterances whose meaning could not be interpreted as true or false were viewed as fundamentally meaning*less*. Austin disputed this on the basis that much of what we actually say is not verifiable in this way and therefore cannot be assigned a truth-value. For example, contrast utterance (1) "there are lots of birds in the sky", with (2) "thank you so much, you're the best". We can neatly classify (1) as a true or false description of an event *if necessary*, however we cannot ascribe a truth-value to (2). Instead, (2) *is* the event itself, which in this case is the act of giving thanks. Initially in his analysis, he termed utterances of type (1) ‘constatives’, meaning utterances that derive meaning from being deemed true or false. Utterances of type (2), he termed ‘performatives’ which instead of being analysable according to truth-conditions, rely instead on a set of ‘felicity conditions’ which judge whether its use is appropriate in context. For our example utterance (2), I would likely feel satisfied that felicity conditions were met (and ratify it as an appropriate thing to say) if you said this to me after I watered your plants while you were away on holiday, but not if I had just asked if you had seen the heron in the park.

Many traditional truth-conditional accounts of meaning construction regarded performative type utterances as peculiar exceptions to a linguistic system that on the whole derived meaning independent of context (Carnap, 1988; Davidson, 1967; Lewis, 1972). The practical difficulty with this standpoint is that utterances that are *use*-conditional and context-dependent are highly prevalent in everyday interaction. For example, demonstrative and personal pronouns (this, that, he, she), deictic locatives (here, there), temporal terms (then, now), verbs (come, go). All of these expressions are the stuff of everyday interaction yet can only derive meaning from their use in context and not according to a truth value (for example, who I mean to refer to using “he” will change according to the situation).

Later in his analysis and with examples like these in mind, Austin concluded that it was not meaningful to posit a division between constatives as “truth-bearers” and performatives as “action-performers” (Levinson, 1983, p. 235), arguing instead that all utterances were performatives, and only a subset of performatives were constatives. As such, he considered that *all* utterances comprised three simultaneous acts.

i. **the locutionary act**: the behaviour, the physical act of the utterance (the speech, the gesture)

ii. **the illocutionary act**: the intention behind the behaviour (the speech act)

iii. **the perlocutionary act**: the effect on the hearer, regardless of (ii), i.e., whether the effect was intended or not

Austin's student Searle (1976) built on this work by proposing an expanded speech act taxonomy which detailed a range of intentions (or "illocutionary points"), comprising representatives (beliefs about the world, e.g. statements), directives (ways to bring about changes using your conversational partner, e.g. requests), commissives (explicit markers of intention, e.g. promises), expressives (windows onto psychological states, e.g. thanks, praise, blame), and declaratives (ways to literally bring about real world change, e.g. declaring war, pronouncing a husband and wife). If we apply Searle's extended speech act taxonomy to our existing examples, we might analyse them as set out in Figure 1.

Figure 1

Example Utterances coded using Searle's Speech Act Taxonomy

(1) **Locutionary act:** "there are lots of birds in the sky" **Illocutionary act:** representative (an expression of what a speaker believes the world" **Perlocutionary act**: hearer looks up at the sky, attends to the birds, and responds.	(2) **Locutionary act:** "thank you, you're the best" **Illocutionary act:** expressive (refers to psychological states) **Perlocutionary act**: hearer feels appreciated and is likely to water plants for future holidays.

However, how locution, illocution and perlocution interact in everyday conversation can be ambiguous. For example, it could be argued that the majority of utterances potentially accommodate a number of perlocutionary meanings. For example, utterance (2) could have the perlocutionary effect of genuine appreciation, or if said sarcastically in a context where I said I was too busy to water your plants, could be a particularly withering put-down. Utterances can also have unintended perlocutionary effects, (1) for example could have drawn my attention to dark clouds in the sky and caused me to reach for my umbrella rather than appreciate the natural beauty of the scene. Utterances can also carry a primary illocutionary force, and a secondary indirect one, for example, if you ask, “what shall we have for dinner?”, and I reply “please, I just got home”, the primary illocutionary act could be interpreted as “I don’t know what to have for dinner”, and a second, expressed *indirectly,* could be “can I please have a minute to take my coat off?”, neither of which are indicated through the formal properties of the locutionary act. Clearly, as hearers, as well as decoding these formal properties to arrive at meaning, we often have to make an inferential leap to determine the illocutionary force actually intended by the speaker**,** prompting many to adopt models of language that distinguish between linguistic code (semantic meaning, decode word and structures) and inference (pragmatic meaning, inferring intentions) (Grice, 1957; Grice, 1975; Sperber & Wilson, 1986).

It is thought that we select an interpretation from the array of possible illocutionary forces by appealing to a principle which is considered the “backbone of all of pragmatics” (Mey, 2013, p. 595). That is Grice’s cooperative principle which states “make your contribution such as is required, at the stage at which it occurs, by the accepted purpose of the talk exchange in which you are engaged” (Grice, 1975, p. 47). From this overarching principle follow four maxims which represent behaviours that hearers can assume speakers are using when communicating, and which narrow down the possibilities of what it is I think you are trying to do with your utterance. These are the conversational maxims of Quantity (be as informative as required, and no more or less so), Quality (be truthful), Relation (be relevant) and Manner (avoid obscurity and ambiguity). For example, I could infer the illocutionary force of utterance (1) to mean look at *all* the birds in the sky, rather than just a subset of the birds, by assuming that the speaker is acting in accordance with the maxim of Quantity (otherwise they would have said "look at all the *blackbirds* in the sky"). Note, these maxims can be deliberately flouted to create irony or sarcasm, as in the case of utterance (2) which when uttered outside of the context of having recently helped somebody, would be sarcastic or humorous, because it flouts the maxim of Quality. Meaning in these cases is recovered by appealing to the overarching cooperative principle that you are making your contribution as exactly required.

Sperber and Wilson (1986) take an alternative perspective, arguing that Gricean maxims can be replaced by a single principle, that of Relevance. Unlike Gricean maxims, this is not a behaviour we assume and violate for various communicative purposes, but instead we are forced by cognitive mechanisms and biases to a) be relevant when communicating, and b) to expect relevance from the communication of others. All of our communicative acts bring about an expectation of relevance because they are ostensive, that is a signal to our interlocutors that our act is worthwhile attending to and worth the processing effort it would require to interpret as *relevant.* They argue that interpretation involves the expression and comprehension of intention across two layers. First, each act has an informative intention (this is the '*what';* simply *what* we are communicating about), and a communicative intention (this is the '*that';* a signal *that* we are communicating intentionally) which guarantees our message will be deemed relevant by the addressee. The authors suggest that in the mind, these intentions are nested in a structure of metarepresentational beliefs that are potentially fourth-order iterations (Sperber, 2000). For example, the intentions for utterance (1) would encompass the following embedded intentions in order; (fourth order) I intend (third order) that you believe (second order) that I intend (first order) that you believe that there are birds in the sky. This is not universally accepted however, with others arguing for a simpler means of combining rather than nesting intentions (Gomez, 2007; Moore, 2014), which may be easier to reconcile with the fact that speech acts develop very early in infancy (see section 1.2.2).

In sum, humans are able to convey a wide range of intentions through speech acts, and this potentially relies on fairly complex reasoning processes (Gricean Maxims) or cognitive mechanisms that strive for efficiency but entail embedded and recursive structures of intention (Relevance Theory). However, it is difficult to harmonise this with the fact that infants also use speech acts to get things done, and indeed do so before they have acquired even the first word of their conventional language. The next section charts the development of intention through speech acts in infancy by summarising empirical studies that have developed speech act taxonomies for use in infancy. We go on to explore some of the major challenges to speech act analysis and consider the plausibility of infants engaging in communication intention in finer detail.

1.2.1 The Development of Speech Acts in Infancy

At around the same time that Searle was expanding Austin's taxonomy of speech acts (1976), there was a recognition in developmental psychology (Greenfield & Smith, 1976) that studying the emergence and use of speech acts in infancy could represent a more effective method of charting development than measures across other domains, i.e., syntax (Bowerman, 1973), semantics (Brown, 1973), and phonology (Stoel-Gammon, 1987). Furthermore, speech acts were seen as a useful method to assess an infants' motivation and readiness to communicate while still preverbal and communicating primarily through gestures, idiosyncratic vocalisations, and other paralinguistic cues (Coggins & Carpenter, 1981).

On usage-based accounts, the emergence of nonverbal speech acts in infancy are seen as manifestations of significant step-changes in cognitive development and in social understanding from 9 months of age (Tomasello, 2010). They are thought to demonstrate the infant's newly formed ability to engage in episodes of joint attention with others (Tomasello, 2010) and to express and recognise communicative intention (Cameron-Faulkner, 2014b). Jointly attending to objects and events with their caregivers represents a qualitative shift for the infant from interacting only dyadically with either a caregiver *or* an object separately, to integrating all three triadically (Bakeman & Adamson, 1984). It is thought that triadic joint attention represents two people "experiencing the same thing at the same time", but more crucially "knowing together that they are doing this" (Tomasello & Carpenter, 2007, p. 121). This provides the framework for a mutually shared common ground between speakers that enables collaborative communication and an understanding of others, as not only attentional, but intentional beings who have recognizable communicative intentions (Tomasello & Carpenter, 2007). It is important here to note that speech acts when applied to infancy could feasibly be better termed 'communicative acts' (Casillas & Hilbrink, 2020) to explicitly encompass the nonverbal behaviours that represent the earliest speech act use, however we stick with the term speech acts for continuity.

The most detailed early analysis of the development of speech acts in infancy was undertaken by Bates, Camaioni and Volterra (1975) in their seminal and pioneering longitudinal analysis of three Italian infants. Adapting Austin's three levels of meaning, they charted the infants' journey from a perlocutionary phase (where an infant has an effect on others by crying or smiling but has done so without intention), to an illocutionary phase (a period where the infant uses non-verbal communicative behaviours to effect changes in their listeners and the world around them, and does so intentionally), and finally onto the locutionary phase (where the infant can express intention using conventional language in place of their pre-verbal behaviours). Through careful naturalistic analysis of the communicative behaviours of their infants, they found that two fundamental speech acts emerged at around 10 months:

i) Protoimperatives: the infant uses their caregiver as a means to obtain desired objects and actions, an act of requesting

ii) Protodeclaratives: the infant uses objects and actions to obtain and share in their caregiver's attention, an act of commenting

Infants initially used the gestural modality, through giving and showing objects and index finger pointing, to signal these basic intentions, as well as simultaneously coordinating gaze to the caregiver. Chapter 3, section 3.1.1.2 expands on their findings in detail but what is important here is that the principal aims of Bates et al. (1975) were to demonstrate how speech acts expressed through conventional means (i.e., words or locutionary acts) are actually continuous with and come to replace those expressed gesturally as protodeclaratives and protoimperatives and highlight continuity between the pre-linguistic and the linguistic. This was in line with contemporaries such as Bruner (1975) who also argued that pre-linguistic speech acts were continuous with the linguistic, and that speech acts should be considered the key unit of analysis to study language development. He emphasised the important role of play in allowing infants to express intentions which are then reciprocated by the caregiver and reinforced, forming the basis of turn taking and conversation. Dore (1974), who also saw the speech act as the natural unit of analysis for pragmatics, developed a broader speech act taxonomy to chart the development through infancy. His primitive speech acts comprised infant initiated acts such as labelling, requesting, calling, greeting, as well as responsive acts, such as answering and protesting, and categories for repetition and practising. He believed that words and non-conventional prosodic patterns were "holophrases" representing whole sentences but counter to Bates and Bruner, that these were not continuous with preverbal acts.

In 1981, Coggins, Carpenter and Carpenter (1981) built on the work of Bates et al (1975), as well as Chapman (1981) and Halliday (1975), by creating the Communicative Intention Inventory (CII), initially as a clinical tool. The CII expands the number of speech act categories to include comments on objects/actions, requests for objects/actions, requests for information, answers, acknowledgements and protests. Critically, it encoded information about modality and provided detailed operational and behavioural guidelines for naturalistic observation, and as such was able to obtain a high interscorer reliability (.91). For example, below is instruction on recognising the communicative intention comment on object which encompasses a theoretical and several behavioural definitions:

> **'Comment on object:** Direction of the listener's attention to some observable referent. An intentional behavior that appears to call the listener's attention to some object identified by the child.
>
> **Gestural or Gestural-Vocal**
>
> a. Extends arm to show entity already in hand; may vocalize.
>
> b. Picks-up an entity and immediately shows it to adult; may vocalize.
>
> c. Points to, looks toward or approaches entity; may vocalize.
>
> **Verbal:**
>
> a. Extends arm to show entity in hand and produces a word.
>
> b. Picks-up entity and immediately shows it to adult and produces a word.

c. Points to, looks toward or approaches entity and produces word or word combination.

d. Produces a word or word combination that refers to an entity not existent in the immediate environment (generally the word/word combination will either have or require a form of the copula or the word have).' (Coggins & Carpenter, 1981, p. 241)

In the 1990's, Ninio et al. argued that the CII was "overly restricted" (1994, p. 163), with too few categories which they felt stemmed from its clinical application as a tool to evaluate infants with restricted communicative ability. They developed a fine-grained taxonomy, the Inventory of Communicative Acts-Abridged (INCA-A) with over 60 categories of speech act, and analysis on two levels, the *individual utterance level*, and a superordinate *interchange level* that defines what the individual utterances are trying to bring about in the social situation in combination with each other (Ninio et al., 1994). The individual utterance level categories have their roots in the speech act theory of Austin and Searle. The interchange level meanwhile integrates a sociological perspective aligning to theories of face-to-face interaction (such as Goffman (1961) and Rommetveit (1974)) wherein meaning is continually constructed and reconstructed only through discourse, and in this way represents a clear break from previous 'utterance only' taxonomies which do not provide a mechanism to understand real world 'talk' at a higher level of organisation.

One of the obvious practical advantages of the INCA-A is that it can be used through infancy and into childhood to capture trajectories and continuity for longitudinal studies. They used the INCA-A in a seminal study with a comparatively large sample size (N = 100), using a semi-structured free play scenario. In doing so, they were able to demonstrate that between 14 and 18 months, the amount of intentional communicative acts made per minute by the infants almost doubled, and that the proportion of these attempts interpretable as speech acts rose from just under half of all attempts at 14 months to 79% at 21 months. At 14 months, on average, infants had a repertoire of 3.79 speech act types, rising to 10.50 types at 20 months and the most commonly expressed speech act types at 14 months were akin to Bates et al. protodeclaratives (namely marking the transfer of an object and events, and declarative statements). By 20 months, statements remained the most frequently expressed communicative act, followed by answering a wh-question, and requesting (in the imperative motive). As before, Chapter 3 section 3.1.1.3 explores their analysis in much finer detail, but most important to note at this stage is the authors' attempts to provide an incredibly rich picture of infant's communicative ability outside of vocabulary or syntax, positioning speech acts front and centre and giving "fullest possible credit to children for unconventional and non-verbal expressions of intents" (Snow et al., 1996, p. 77). In Chapter 3 section 3.1.1 we also expand upon the wealth of experimental and naturalistic data on infant speech acts captured since this pioneering study and those of the 1970's, but for now we turn to some of the key challenges in using speech act analysis in infancy.

1.2.2 Difficulties With Speech Act Analysis

There are several major difficulties with the application of speech act theory to studies in infancy, many fully conceded by researchers in the field. They can be divided roughly into four main challenges. Firstly, which of the existing speech act taxonomies to select? As Cameron-Faulkner argues, the myriad purposes that speech act taxonomies have been put to, has led to an abundance of schemes "with an almost one-to-one relationship between taxonomy and researcher" (2014b, p. 41). It is therefore difficult to compare studies to gain an understanding of patterns of emergence and norms for the rates of expression that would be comparable to using Mean Length Utterance to evaluate grammatical ability and vocabulary checklists for lexical development (Fenson et al., 1993; Ninio et al., 1994). The preceding section demonstrates that taxonomies can range from two categories of speech act (Bates et al., 1975) to over 60 (the INCA-A), but as Searle and Vanderveken argue, the types of actions we can perform with communication is not infinite and a systematic gold standard is at least theoretically possible (1985). For many however, the choice of speech act taxonomy is motivated simply according to what is practically possible, which leads us onto the second major challenge below.

Richer fine-grained speech act coding schemes such as the INCA-A are undeniably time and labour intensive to apply to large samples (as per Snow et al., 1996). The challenge is compounded if one is interested in going beyond the coding of speech act functions to simultaneously consider the forms of communication, such as gaze, modality and expressive vocabulary, to provide a holistic picture. Formal analysis is not always a feature of speech act analyses presumably in some part due to the intensity of the task (Snow et al., 1996), but the question of *how* infants signal intention can be illuminating, for example in studies that show that vocalisations, (Papaeliou & Trevarthen, 2006), prosody (Cameron-Faulkner, 2014a), and gaze (Donnellan et al., 2020) can be an important marker of pre-verbal intention.

Thirdly, there is the ever-present danger of observers over-ascribing meaning and function to infant utterances. Speech acts and intentions are not directly observable, do not have 1:1 mapping with form, and as we have seen in section 1.2, necessarily involve a process of inference. We know that caregivers often over-ascribe meaning to utterances in infancy (Keller & Schölmerich, 1987; Miller & Lossia, 2013; Snow, 1977), particularly early on while the infant is still operating in the perlocutionary phase and not bringing about changes in their environment *intentionally*. However, by ‘appearing’ to act with communicative intention, infants are actually eliciting responsive behaviours from their caregivers that serve to scaffold their learning. So in reality, even though speech act analysis could reflect more the ‘appearance’ of acting with communicative intention, we argue that this is still an important measure of the type of learning environment infants are helping to bring about for themselves (Scarr, 1992) and which is likely to contribute to their later communicative proficiency (Donnellan et al., 2020; Goldstein et al., 2009). In many ways, "intersubjectivity has to be taken for granted, in order to be achieved" (Rommetveit, 1974, p. 56). Furthermore, speech act coding schemes that provide behavioural 'hooks' (such as the CII where speech acts are given behavioural definitions that encode information about the modality they will likely be using when performing a specific speech act; Coggins & Carpenter, 1981), can help to ensure observer judgement is more systematic and consistent by constraining the possible interpretations for the observer according to typical accompanying behaviours as well as context.

Finally, and related to the previous point, how can we be sure that when we assign a speech act to an infant's behaviour, it is actually intentional in both the informative and communicative sense? That infants could be operating with the types of complex metarepresentational processes put forward by Sperber and Wilson on the principle of Relevance (Sperber, 2000, see section 1.1.2) is subject to debate. In some ways, infants appear to be cognitively unprepared to be able to take the perspectives of others in this way, for example in false belief tasks before the age of three, although see Rakoczy (2022) and Southgate (2020) for substantial recent debate on this topic. Certainly, on a usage-based account of communicative development such as Tomasello's (2010), the perspective taking abilities that a rich understanding of intention would entail are in place as early as 9 months and manifest in early speech act use. Experiments suggest that infants are keen to ensure that not just their informative intention but also their *communicative intention* has been recognised, (e.g., Behne et al., 2012; Boundy et al., 2019, Liszkowski et al., 2004). This counters arguments that infants are motivated to perform speech acts only to egocentrically obtain objects or attention to the self (Moore & Corkum, 1994; Shatz & O'Reilly, 1990) and not to connect with others.

Others have sidestepped the lean/rich debate by positing alternative pathways for infants' emerging engagement with speech acts. Firstly, some have put forward an alternative structure whereby informative and communicative intentions are not nested, but actually two separate second-order structures that occur simultaneously, thereby cutting cognitive and processing demand (Gomez, 2007; Moore, 2014). For example, for utterance (1) in section 1.2, the informative intention would entail (second order) I intend (first order) that you attend to birds in the sky. Then, a separate communicative intention structure would entail (second order) I intend (first order) that you recognise *that I am communicating.* Secondly, constructivist accounts argue that these rich social-cognitive skills do not have to be either in situ, or not, in early infancy. Instead, they are gradually constructed *through* repeated interactions (Carpendale & Lewis, 2004) and so something that initially begins as an unintentional routine, becomes intentional through experience. While this debate is not the main focus of the subsequent thesis, it is important to conclude before moving on that while we cannot articulate exactly how infants represent mental states during interactions, speech acts at the very least represent a burgeoning grasp of others as intentional agents and are an important measure for communicative development despite some unresolved theoretical and practical challenges.

The next section shifts to consider the concept of *individual differences* which is a potentially valuable application for speech act analysis and is the basis of empirical work in this thesis. We firstly outline a framework by Kidd et al. (2018) which argues that individual differences must be accounted for in empirical work on the development of communication in infancy, and then argue that the study of variation in the early development of *pragmatics* in particular is understudied but essential. We broaden the scope of this literature review at this point from focusing exclusively on speech acts (as in the previous section) to pragmatics in general since speech acts are a fundamentally pragmatic phenomena (i.e., pertaining to the *use* of communication in an interpersonal context). Considering pragmatic abilities as a whole (and not just at the speech act level) allows us to make predictions about individual differences based on usage and formal based accounts and for us to argue that variation in *any pragmatic phenomenon* should be expected, evidenced and on a practical level can have challenging consequences for the individual.

1.3 Individual Differences

Variation is a defining feature of almost every level of human existence, from our biology to how we organise on a community or social level, and this is particularly true of our cognitive processes, for example memory and attention (Kane & Engle, 2002; Vogel & Awh, 2008). However, the linguistic and psycholinguistic disciplines have tended to resist integrating the prospect of variation into a) their theories which tend to present universal capacities (Levinson, 2012) and b) their methodologies which can often disproportionately rely on experimental paradigms that are designed to dampen variation (Cronbach, 1957; Sternberg & Grigorenko, 2001; Underwood, 1975). This is valuable and essential work, however, it is crucial that we consider individual differences in order to provide a picture of human communication that is not just fuller and more accurate, but also more inclusive and equitable (Kline et al., 2018; Rogoff et al., 2017).

The subsequent chapters in this thesis are framed by a recent call by Kidd et al. (2018) for theories of communication to account for individual differences in three key ways:

1. Theories must account for the **Existence Imperative** which holds simply that individual differences may exist and be observed in empirical work

2. Theories must account for the **Architectural Imperative** which dictates that relationships may exist between individual differences in components of communication that have been posited as separate domains. Associations and disassociations therein may provide evidence of common or distinct underlying mechanisms and can contribute to our understanding of the architecture of communication.
3. Theories must account for the **Environmental Imperative** which holds that relationships may exist between communicative behaviours and environmental and experiential factors, such as input and socioeconomic status.

That there are individual differences in infants' early formal language development is well established, particularly for vocabulary size and growth. At 10 months, some children express ten times the number of words as others, and this disparity persists through to 16 months (Fenson et al., 1994). While at 16 months, a child scoring in the 90th percentile for vocabulary production can recognise the same amount of words as a child scoring in the 10th percentile at 26 months (Frank et al., 2017). These individual differences then persist into childhood (Field, 2010; Hoff, 2013), having potentially profound impact on their literacy (Snowling & Hulme, 2012), academic achievement (McCormack et al., 2011), and then later on in life in higher educational and employment trajectories (Clegg et al., 1999; Johnson et al., 2010). From 14 months, individual differences in the development of vocabulary also start to show *between genders* (Carpenter, Nagell, et al., 1998). Girls generally acquire vocabulary quicker than boys and by 16 months, girls are producing 70 more words than boys on average (Fenson et al., 1994). Interestingly, girls are also more likely to engage in other communicative behaviours than boys such as gesture (Özçalişkan & Goldin-Meadow, 2010), eye contact (Lutchmaya et al., 2002) and imitation (Chipman & Hampson, 2007).

Furthermore, associations between familial Socioeconomic Status (SES; factors such as familial income, parental education, see Chapter 5, section 5.1.1) and early vocabulary development are striking, and already established as early as 18 months (Arriaga et al., 1998; Dollaghan et al., 1999; Fernald et al., 2013; Hart & Risley, 1995). The detrimental impact of language-based disparities to both the life of the individual, and to society generally, has led to its categorisation as an urgent public health priority (Law & Levickis, 2018).

Relatively little is known, however, about the nature of variation in *pragmatic* abilities early in infancy, and there is acknowledgement that it has been comparatively neglected (Kidd et al., 2018; O'Neill, 2014). Despite this, what work there is on individual differences in pragmatics (generally with older children) suggests adverse outcomes later in life for those who struggle with pragmatic aspects of communication as a child. For example, it appears that it is pragmatic, and not structural language difficulty, that correlates with behavioural difficulties. In a study with children at 4 years using the Children's Communication Checklist, a diagnostic tool for identifying communicative disorders, including Pragmatic Language Impairment (PLI) (Norbury et al., 2004), it was performance on the specifically pragmatic elements of the CCC-2, and not structural language measures, that predicted behavioural issues, namely hyperactivity and a lack of prosocial behaviour (Ketelaars et al., 2010).

Pragmatic difficulties also have a particularly strong impact on peer-to-peer interactions in childhood. For example, children in mainstream education aged between 5-6 years, were divided into two groups according to their performance on the Test of Pragmatic Skills (Shulman, 1986), 1) low skilled and 2) average to high skilled. Average to high skilled children had negative feelings towards interacting with their low skilled peers even though they themselves had adapted to their own behaviour to show sensitivity to their peers' difficulties (Murphy et al., 2014). This negative rating of peers with pragmatic difficulties and challenges forming social relationships can persist until adolescence (Laws et al., 2012), and into adulthood (Whitehouse et al., 2009). This is perhaps not surprising since skills of a pragmatic nature (expressing and recognising intentions, perspective taking, turn taking, using eye contact appropriately, humour) are especially helpful tools to help us build relationships, make social connections, and to cooperate on joint activity (Gottman et al., 1975; Helland et al., 2014; Vázquez et al., 2013). Finally, pragmatic difficulties are correlated with academic difficulties (Barbarin, 2013; Timler et al., 2007) and problems gaining employment (Eaves & Ho, 2008; Lewis et al., 2008).

There is a clear practical motivation to make comparable efforts to capture early individual differences in pragmatics as have been made to identify those in vocabulary development. However, there are likely to be theoretical benefits also. The next sections discuss the importance of applying Kidd et al's (2018) existence, architectural and environmental imperatives to the field of pragmatics in turn.

1.3.1 The Existence Imperative: Formal and Usage-Based Accounts

Recall from section 1.1.1 that formal and usage-based accounts of communication differ in their positioning of pragmatics within the human communication system. Unsurprisingly, their predictions about individual differences in the development of *language* also diverge. Formal linguistic theory argues that the acquisition of language is a product of the activation of latent abstract representations of syntax in the mind that are stimulated by language input and productive from the onset (Gleitman, 1990). Moreover, the acquisition process is seen as universal and invariant, and any individual differences therein may be reflective of a) variation in supporting, *but not connected,* cognitive processes such as memory and processing skill, or b) represent exceptional cases of genetic disorders affecting grammatical development (van der Lely & Pinker, 2014). It is interesting to note that formal accounts would expect variation in vocabulary since words vary according to the specific language being acquired, and there is a significant learning factor (Kidd et al., 2018). However, formal linguistic theories are unlikely to even consider individual differences in pragmatics since they set clear boundaries between pragmatics and core components of language, with the former outside of their domain of analysis (Chomsky, 2014).

Conversely, usage-based accounts of language acquisition argue that abstract representations of language structure are constructed gradually from input and supported by socio-cognitive abilities such as joint attention and intention recognition (as set out in section 1.2.1; Tomasello, 2003). These theories do predict individual differences as a natural feature of the acquisition process (Kidd et al., 2018). However, usage-based accounts have tended to eschew individual differences studies in early pragmatic behaviour in favour of establishing universals and demonstrating communicative intention (Behne et al., 2012; Liszkowski et al., 2004b). Furthermore, much work in the field has traditionally focused on how children learn forms, rather than functions (Lieven, 2016, p. 347). This is certainly justifiable, given the initial need for usage-based accounts to develop a theory as to how children can abstract structural rules from input that would stand up to scrutiny from formal accounts (such as poverty of the stimulus arguments). We simply argue that usage-based accounts can now begin to be broadened to *allow* for variation as demanded by the existence imperative.

1.3.2 The Architectural Imperative: Associations Between Pragmatic and Formal Language Skills

The question of whether aspects of communication are served by so called ‘vertical faculties’ which are specialised modules that are domain specific, or ‘horizontal faculties’ which are domain general and operate across multiple components is a longstanding one (Bates, 1988; Fodor, 1983). Correlational analyses of individual differences across proposed components of communication have significant value in providing evidence for distinct or common mechanisms at play (Bates et al., 1995; Kidd et al., 2018). Formal linguistics would predict no or little association between sub-components of language which they see as specialised vertical faculties (Yang et al., 2017). However, usage-based accounts would expect patterns of association between communicative abilities since they posit no (or at least "blurred") boundaries between the components of grammar, semantics and pragmatics (Kidd et al., 2018; Ninio & Snow, 1999). We turn below to correlations between pragmatics and vocabulary, and then interrelations between pragmatic skills themselves.

1.3.2.1 Pragmatics and Vocabulary. Recall that many usage-based accounts of communication suggest that all linguistic phenomena is pragmatic in nature and origin (Bates et al., 1982; Moore, 2017; Scott-Phillips, 2017), and that linguistic ability is the progeny of the recognition and expression of intentions preverbally in infancy (Bates et al., 1975; Bruner, 1975; Cameron-Faulkner, 2014a; Csibra, 2010; Levinson, 2019; Scott-Phillips, 2017; Tomasello, 2010). On these accounts, words cannot be learned and understood outside of the pragmatic, social and contextual factors that govern their usage, put simply "knowing the meaning of a word is nothing but knowing how to use it" (Grassmann, 2014, p. 153)

Indeed, a close developmental relationship is borne out empirically in experimental studies of how infants and children approach reference resolution paradigms wherein they are introduced to a novel word and they work to identify an appropriate referent. In doing so, infants provide evidence that they call on a multitude of skills to guide their interpretation that could be characterised as *pragmatic* in nature. Firstly, they start to reliably follow the gaze and points of their interlocutors to identify the referent of a novel word from 18 months (Baldwin, 1991; Booth et al., 2008; Brand, 2000; Briganti & Cohen, 2011) which could theoretically entail not just simple mapping, but the integration of three entities in triadic joint attention, and the recognition of the fact *that* the speaker is communicating something (i.e. ostensive communication). They are also guided by speaker displays of emotion (Berman et al., 2013; Tomasello & Barton, 1994) and are sensitive to what information is in common ground between themselves and the speaker (Grassmann et al., 2009). This gives credence to the socio-pragmatic accounts of word learning of Clark's principle of contrast and conventionality for example (1990) which holds that infants assume that a difference in form equates to a difference in meaning.

Furthermore, the amount of time infants spend with their caregivers in joint attention (the framework thought to allow for the understanding and expression of intentions) predicts vocabulary development (Carpenter, Nagell, et al., 1998; Markus et al., 2000; Morales et al., 2000; Tomasello & Farrar, 1986). Chapter 3 section 3.1.2.1 goes into much more detail on the empirical connections between pragmatics and formal language ability early on, but for now we can conclude that usage-based accounts would expect a close relationship.

1.3.2.2 Interrelations Between Pragmatic Skills. It is not so clear whether pragmatic skills themselves are manifestations of common underlying social and cognitive mechanisms that would be expected to intercorrelate through development, or a set of loosely connected phenomena that would be expected to show varying patterns of associations. For Levinson, the pragmatic skills reflecting the proposed universal capacity for interaction are in reality a "bric-a-brac of useful oddments" (2019, p. 197). For him, pragmatic skills like turn taking, gesturing, gaze coordination and initiating and responding to joint attention would not constitute a specialised domain and would display different patterns of development in ontogeny. Indeed, an interesting empirical backing for this theory comes from clinical literature, where intercorrelations in pragmatic abilities have been used for the development of valuable clinical tools for diagnoses of pragmatic/social language impairments across a range of atypical populations (e.g., The Children's Communication Checklist: CCC-2; (Bishop, 2003)). In developing the CCC-2, it became clear that pragmatic impairments affected quite heterogeneous subsets of pragmatic skills that appeared to have no underlying commonality so that aiming to profile children as being universally impaired in pragmatics was not feasible because “such discrete groups are not realistic” (Norbury et al., 2004, p. 362).

Individual differences studies in the development of joint attention have had mixed results. For Tomasello (1995) for example, pragmatic skills would be expected to correlate because they relate to a common social-cognitive model (SCM) of joint attention. While there has been some empirical support for this (Carpenter, Akhtar, et al., 1998), Mundy et al (2007) demonstrated disassociations between the ability to respond to joint attention and the ability to initiate joint attention between 9 and 18 months which suggests that behaviours such as following gaze and infant pointing are manifestations of separate attentional processes despite both being pragmatic in nature. Chapter 3, section 3.1.2.1 summarises this and other empirical work in much more detail, but overall, exploring interrelations of early social communicative behaviour synchronously in typical populations would contribute to our thus far mixed picture of how pragmatic skills hang together in infancy.

1.3.3 The Environmental Imperative: Pragmatics in Social Context

If all meaning *is* use (Wittgenstein, 1953), possible only in the context of others and the world around us, then it follows that aspects of our environment have the potential to impact the way we use and understand communication, simply because both the immediate and distal aspects of our environments are themselves subject to immense variation. Bronfenbrenner (1977, 1996) conceptualised development as the result of bi-directional relationships between concentrically nested systems that exert influence on each other either directly or indirectly. His ecological model of development states that development is:

> the progressive, mutual accommodation between an active, growing human being and the changing properties of the immediate settings in which the developing person

lives, as this process is affected by relations between these settings, and by the larger contexts in which the settings are embedded (Bronfenbrenner, 1996, p. 21)

First, the infants' immediate setting, the microsystem, comprises whatever the individual undergoing development is in direct contact with (objects, activities, interpersonal relationships at home or at school). The mesosystem represents how these interact with each other (for example, the influence of home on school and vice versa). The exosystem is a setting in which the individual does not participate themselves, but which influences their microsystem indirectly (for example, the parents' workplace dictating work/home balance). Finally, the macrosystem comprises the wider societal ideological and organisational structures of institutions and cultural norms. These levels of influence can be illustrated neatly using language acquisition as an example. The quantity and quality of talk the infant hears early on correlates positively with their later language outcomes (Hart & Risley, 1995; Hoff, 2003; McGillion, et al., 2017). However, this direct microsystem influence can depend on influences from exosystem settings that the infant themselves never participates in. For example, caregivers' talk, and interaction styles can be influenced by their own levels of education or stressors from their working or financial situations. It can also be impacted by beliefs about their own role in parenting (Bradley & Corwyn, 2002; Rowe & Casillas, 2011), which can be shaped by cultural norms within the macrosystem.

An ecological approach to development allows us to explore individual differences as interactions between infant and caregiver behaviour, as well as with contextual and environmental variables, and indeed much valuable work has been undertaken to elucidate these influences on the development of infant vocabulary (Dollaghan et al., 1999; Fernald et al., 2013; Hoff et al., 2002). However, environmental influences on the development of early *pragmatic* abilities are comparatively understudied (Kidd et al., 2018), despite the centrality many accounts afford to pragmatics in communicative development (see section 1.2). This is also surprising since pragmatic skills should be particularly susceptible to individual differences as they are by their nature culturally defined and constructed (Frazier Norbury & Sparks, 2013). As such sociocultural values are highly likely to shape pragmatic aspects of communication such as the use of various interaction and discourse styles, humour, and use of eye contact, for which there is an acknowledged lack of standardisation or norms (Nadig et al., 2010; Norbury et al., 2009). Chapter 5 goes into more detail on the notable exceptions to the dearth of existing empirical work on the environmental impact on pragmatic development, but overall, understanding how these ecological aspects exert influence on pragmatics is an essential step in our understanding of communicative development.

1.4 Questions for This Thesis

The preceding overviews aimed to highlight the key differences between formal and usage-based accounts of communicative development, with particular focus on the pragmatic phenomenon of speech acts, which emerge before (and for some, are antecedent to) the infants' first words. We have also highlighted the potentially adverse consequences of early deficits and delays in pragmatic development across the life course, and in doing so have argued for a fuller understanding of individual differences in pragmatic abilities in infancy, comparable to our understanding of variation in vocabulary development. We have framed the subsequent chapters in terms of the three imperatives of Kidd et al. (2018) which argue that theories of communication must account for individual differences.

Chapter 2 describes the methodology for the collection and analysis of our principal measure, namely the frequency of expression of a range of communicative intentions in a sample of 18-month-olds, observed in a naturalistic play setting. Modality (whether vocal, gestural, vocal-gestural, or gaze coordinated) and the production of words were also coded manually. This chapter is presented as standalone as the dataset of communicative measures it describes runs throughout the rest of the thesis, forming the basis for separate analyses in each chapter.

Our first empirical study (Chapter 3) set out to accommodate the existence imperative, which is simply to establish whether there are individual differences in communicative behaviours. We tested for variation in the frequency of expression of the communicative intentions and found striking individual differences in rates of use. Secondly, we looked to explore the architectural interplay of these early behaviours, testing for interrelations between the rates of expression of these intentions as well as between these pragmatic measures and a measure of formal language.

In our second study (Chapter 4), we tested for associations between the expression of communicative intentions and performance on a series of structured tasks tapping various social communication skills, including using gaze to solve referential ambiguity, appealing to common ground and repair. In doing so, we wanted to answer calls for a mixed-methods approach that integrates the correlational and the experimental.

In Chapter 5, we acknowledged the environmental imperative, by exploring patterns of associations between the expression of the communicative intentions and environmental variables including socioeconomic status, a quantitative measure of adult linguistic input, and a measure of parental belief about pragmatic skills. Finally, in Chapter 6, we summarise the main contributions of these findings, situating them in broader theories of communicative development, and conclude by highlighting some limitations and directions for future research.

2. Baseline Methodology

Abstract

This stand-alone chapter describes the methodology for the collection and analysis of a dataset of measures for each subsequent Chapter in this thesis. This dataset comprises a comprehensive range of measures of **pragmatic and formal language behaviours** for a cohort of 18-month-olds (*N* = 104) from across the South Yorkshire and East Midlands region and represents a snapshot of **the infants' emerging expressive pragmatic and communicative ability**. A range of methods were used, including naturalistic coding of video data, automated processing of audio data, and parental report. The principal outcome variable regarding the infant's pragmatic ability was a set of **Communicative Intentions (CIs)** coded from naturalistic video of unstructured play between participating infants and their caregivers. Each communicative behaviour produced by the infant during the video was coded according to its CI in the interaction as either a *comment, request, answer, acknowledgement*, *protest*, *greeting* or *game embedded turn* (Coggins & Carpenter, 1981). Formal properties of the infants' communicative attempts were also coded (including whether the intention was expressed *vocally*, *gesturally*, *vocal-gesturally*, or *coordinated with a gaze to the caregiver*). Vocalisations were further coded for whether they included a *consonant-vowel combination* or were a *word* (and whether they were a direct *imitation*). Gestures were coded for whether they were of a given type (i.e., an *index finger point*, *give* or *show*). This provided an indication of *how* infants were expressing CIs in our 18-month sample. Measures of expressive and receptive vocabulary were also collected by parental report.

These measures are used throughout the remainder of the thesis to explore questions about the nature of these early pragmatic and communicative abilities, and this standalone methodology can be referred back to for each subsequent empirical chapter as needed.

2.1 Participants

Participants in this sample were part of a larger longitudinal intervention study conducted by McGillion et al. (2017). This was a randomised control trial (RCT) testing the effects of an intervention designed to increase caregiver contingent talk on the infants' expressive vocabulary (as compared to a non-language-based control intervention focused on dental health). Participants were recruited though a volunteer database maintained by the University of Sheffield's Department of Psychology (Cognitive Development Group). Database volunteers had been recruited either from the nearby Jessops Maternity Hospital or through the Bounty Marketing Group. Furthermore, contact information for families with infants in the South Yorkshire area who fitted inclusion criteria, and where the infant was soon to turn 11 months over a fixed period, was obtained from Bounty and these families were posted or emailed a leaflet to which they could respond if they wished to take part. To take part, infants had to be first born, monolingual (with English as the native language) and had to have been no more than 3 weeks premature with a birth weight over 2.5kg. Caregivers also had to be monolingual English speakers and to have no disabilities that would prevent participation.

At the start of the RCT, 142 infants fitting the criteria above were recruited, randomized and assigned to intervention or control condition when they were 11-months old. By 18 months, the time at which the current dataset was collected, 26 participants had been lost to follow-up (illness N = 1; personal circumstances N = 2; unable to contact N = 21; moved away N = 2). A further 11 participants were excluded at the coding stage for having fewer than 7 minutes of codeable video (N = 7; caused by the infant walking off screen or the cameras being badly positioned), or there having been two adults present during filming (N = 5).

Of the 104 infants in the current sample, 53% were female (*n* = 56), and 47% male (*n* = 47), and the mean age at the first visit (during which the baseline video data was recorded) was 18 months and 23 days (*SD* = 11 days). Of all the primary caregivers, one was male. Socioeconomic status (SES) across the cohort was relatively representative as measured by the 2015 English Indices of Deprivation (IMD). This UK Office of National Statistics measure uses information based on neighbourhood levels of employment, income, housing and healthcare access and in the current cohort, 36% of infants were from the in lowest 3 IMD deciles, 26% from deciles 4-6, and 38% living in deciles 7-10. However, this and other socioeconomic and wider environmental factors are explored in further detail in Chapter 5, section 5.2.2. Ethics approval from the University of Sheffield's Department of Psychology Ethics Sub-Committee was obtained and all participating caregivers gave informed consent for their video and audio data to be used. Infants were gifted a small token of appreciation after completing the 18-month visits (a farmyard jigsaw).

2.1.1 Intervention Condition

As part of the RCT, families who had responded to the recruitment leaflet at 11 months and who had met the inclusion criteria above were assigned randomly to either the caregiver contingency intervention or dental health control condition. Details of the intervention are included below but are not a focus of the individual differences studies presented in this thesis. Nonetheless, where appropriate, analyses are run separately for each condition. In the intervention arm, caregivers were trained using an instructional video to increase the amount of contingent talk to their infants (talk that was contingent upon the infants' current focus of attention) by practising for 15 minutes a day, between the ages of 12 and 18 months, and in the dental health control arm, caregivers were asked to practise toothbrushing techniques and tooth-friendly snacking for 15 minutes a day (see McGillion et al., 2017 for more detail).

Of the 104 infants included in the current sample at 18 months, 56 infants had been allocated to the contingency intervention condition, and 48 to the dental health control condition. Consequently, prior to data collection at 18 months, 53% of the infants in our current sample had been administered an intervention designed to increase the infant's expressive vocabulary. Although analyses were not performed separately according to condition for empirical Chapters 3 and 4, for Chapter 5 (a study of the associations between communicative ability and socioeconomic measures) it was important to examine relations separately for each condition since the intervention was intended to be, and indeed had been, particularly effective in promoting infant vocabulary for families from lower SES backgrounds.

2.2 Procedure

As the infant turned 18 months, the author visited the family at home to collect the naturalistic video and audio data, as well as to administer a questionnaire pack, across two separate visits (typically spaced one week apart). Almost all of the visits were undertaken by the author (92%), and some by research assistants working on the RCT study (8%). Approximately 2 weeks before the date the infant was due to turn 18 months, a reminder was triggered for a Research Assistant to arrange a convenient time for a visit within a window of 4 weeks. All of the families visited had taken part in the RCT at 11 months and were familiar with the procedures outlined below that had also been used to collect data on two previous occasions (when the infant was 11 months, and 12 months).

2.2.1 Materials

To capture the naturalistic video data, two Sony HDR-PJ220E video cameras and tripods were used. For the naturalistic audio data, LENA digital language processors (LENA Research Foundation, 2014) were used, which are lightweight, wearable devices that can be inserted into specially designed clothing and record continually (unless paused or stopped) for 16 hours. Accompanying LENA analysis software (available in the Department of Psychology Babylab) was used to automatically analyse the audio recording and generate quantitative reports about the infant's linguistic behaviour and environment, for example, estimates of the number of infant vocalisations, an adult word count, conversational turns by infant and caregiver, and details of the wider environment (i.e., amount of television audio present).

A questionnaire pack was collated (see Appendix B) and given to the caregiver, presented as one document stapled together, and always in the following order:

- Demographic Measures. Caregiver occupation, highest level of education and annual household income after tax.
- A Measure of Formal Language (Expressive and Receptive Vocabulary). The Lincoln UK version of the MacArthur-Bates Communicative Inventory (MCDI; Meints, 2000). The questionnaire presents a checklist of vocabulary divided into categories (i.e., animals, vehicles, food and drink), and asks parents to rate whether the words are something their infant can understand and say, or whether it is something they can understand but not yet say.
- A Measure of Pragmatics**.** The 'First Communicative Gestures' section of the Language Use Inventory (LUI; O'Neill, 2007). This questionnaire asks parents to indicate whether their infant never, sometimes or often used various gestures such as points, shows and gives for specific functions.
- A Measure of Adult Belief. An adaptation of Becker and Hall's (1989) questionnaire which explored differences in parental beliefs about the acquisition of pragmatics. It asked the primary caregiver to indicate who/what they thought was the primary

influence on the development of various pragmatic skills including turn-taking, appropriate eye contact, greeting and saying please/thank you and staying on topic. For each skill, caregivers indicated whether they believed a) their child would pick up the skills naturally, b) they themselves were the primary influence over their infant's child's pragmatic development, or c) these were skills that their child would learn at school. These are explored further alongside other potential environmental influences on the expression of communicate intentions in Chapter 5.

2.2.2 Visit One

Upon arriving at the family home, the author explained the structure of the session, giving the opportunity for questions to be asked, and handed the caregiver the questionnaire pack and consent form which were to be left with them to fill out at leisure and to be collected on visit two (around a week later).

2.2.2.1 Naturalistic Video Observation Procedure. Next, the two cameras were set up at opposing ends of the family living room, kitchen or playroom (caregiver's choice) and the caregiver was instructed to spend 15 minutes playing with their infant with toys or objects of their choice as they would during a normal play session. As soon as the cameras were positioned, and the dyad was ready, the researcher started the recording and left the room, coming back in after 15 minutes had passed to stop the recording. Next, the dyad was invited to play for another 15 minutes, this time with a set of toys bought by the author (including, a set of felt fruits, vegetables and other food, plastic knives, forks and plates, a set of farm and zoo animals, and a Fisherprice Veterinary Surgery playset), and this was recorded as for the first session. Throughout it was made clear to the caregiver that recordings could be paused if the infant became distressed or needed changing. A questionnaire was given to a subset of caregivers (n = 43) at the end of visit one to evaluate how representative the caregiver felt the recorded play session had been to typical play time with their infant. On a scale of 1-10 (1 being not at all representative, 10 being exactly the same as an ordinary play session), caregivers gave an average score of 8.23 (range 3 – 10), suggesting that the recording was a good approximation of typical dyadic interaction in our sample according to caregiver report.

2.2.2.2 Naturalistic Audio Recording Procedure. If the visit took place in the morning, the author switched on the first LENA digital language processor (DLP), concealed it within a specially designed waistcoat and allowed the caregiver to put this on the infant, after which it would record for 16 hours (unless manually stopped or paused, which the caregiver was instructed not to do). However, if the visit was later in the afternoon, the caregiver was left with instructions to turn on the LENA device early the following morning in order to maximise the time the infant would be awake during the recording. In both cases, an extra LENA, a second waistcoat and instructions were left for a second day of recording, however it was made clear to caregivers that the recording days did not have to be consecutive as long as the second recording had taken place before the date of the second visit (usually around a week later). More information on analysis of audio data from the LENA DLPs to obtain a measure of how many words uttered by adults in the infants' environment is outlined in Chapter 5, section 5.2.2.1.2.

At the end of the visit, a date was arranged for the researcher to return to collect the LENA digital language processor and questionnaires, and to administer a series of structured tasks to test for pragmatic ability (see Chapter 4, section 4.2 for procedural details). Once the researcher was back at the Department of Psychology, the video data was removed from the video camera and stored on the Developmental Study space on the University's secure drive and labelled as 'px - 18m - unstructured/structured play' as appropriate.

2.2.3 Visit Two

At visit two, the author returned to the family home to collect the LENA devices and waistcoats, and the completed questionnaires. If the caregiver had not filled out the questionnaire prior to the visit, they were encouraged to fill out as soon as possible and return using a pre-paid envelope.

2.2.3.1 Pragmatic Tasks. Next, the researcher explained that a series of quick tasks would be carried out with the infant, recorded and would last for no longer than 10 minutes in total. The caregiver was informed that the tasks took the form of fun games with various toys and that they could ask questions or stop the tasks at any time. As for the play sessions, the researcher set up two video cameras on tripods at opposing ends of the family living room, kitchen or playroom (again, caregiver's choice). Four tasks designed to capture infant's early ability to respond to and initiate joint attention for communicative purposes were administered, always in the following order:

- Using Mutual Exclusivity for Reference Resolution
- Following Gaze for Reference Resolution
- Using Common Ground for Reference Resolution
- Requesting and Repair

Tasks were coded post-hoc from the video recordings at the end of the data collection phase. Procedure and Coding scheme for these tasks are presented in Chapter 4, section 4.2 where we look for interrelations between the baseline naturalistic video coding (as set out below) and performance on these structured tasks. Once the researcher was back at the Department of Psychology after the second visit, the video data was again removed from the camera and stored on the Developmental Study space on the University's secure drive. The questionnaires were filed in a locked filing cabinet, also located at the Department.

2.3 Coding of Naturalistic Video

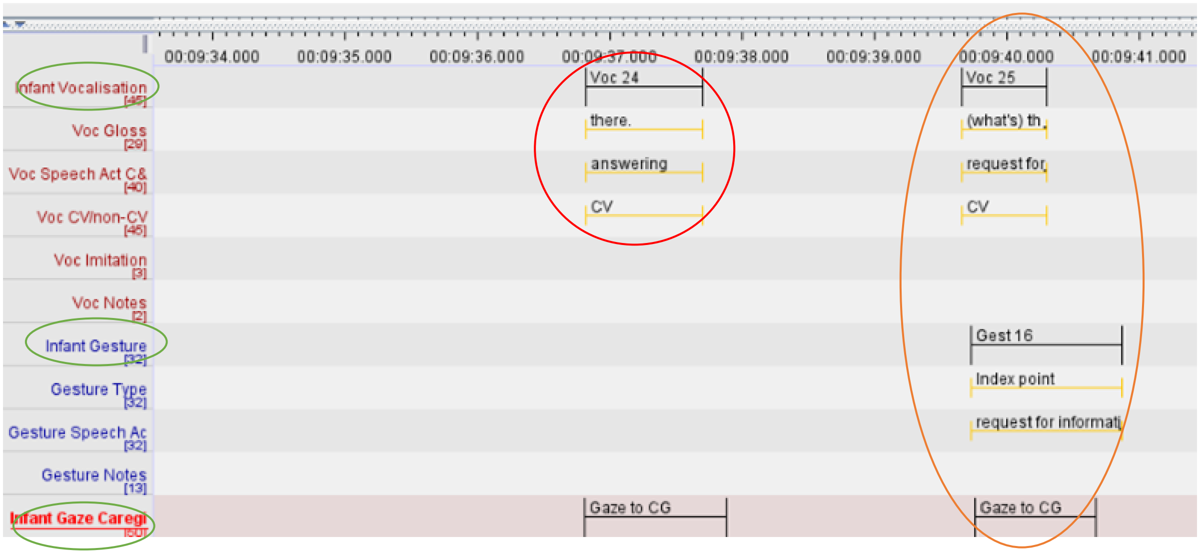
Over 28 hours and 48 minutes of video footage, 10675 individual vocalisations, 2247 gestures and 3254 instances of gaze to the caregiver were coded for the formal and functional properties set out in the section below. At the time of the author commencing coding according to the guidelines below, all of the 104 videos had previously been marked up for vocalisations for the previous RCT study, and of these, 39% of the videos had also been annotated for infant words (see section 2.3.1.3 below). The author coded for all of the remaining behaviours outlined below, with the exception of 14% of videos where vocal canonical properties, gesture types and gaze had been coded by a different researcher first, checked by the author and any discrepancies resolved at the time.

A decision was taken to code only the unstructured play session, and not the structured play session. This was due to constraints on coder timing and the fact that infants were generally quieter during the structured play, possibly due to the appearance of new toys which they tended to focus on in a less communicative, triadic way. *Caregivers* tend to be more vocal during structured, rather than unstructured, recordings according to Tamis-LeMonda et al. (2017), however, only measures of infant communication were of interest in this dataset, and we felt the structured play sessions did not offer as much inducement for the infants to communicate.

Coding of the naturalistic video was undertaken using the free annotation and transcription software ELAN (Wittenburg et al., 2006). ELAN was chosen due to its tier-based structure which supported the analysis of behavioural properties which could also be linked in hierarchical parent/child relationships (see Figure 2), and then cross-referenced for co-occurrence post-extraction. For example, the researcher could insert an annotation each time the infant vocalised on a higher level so-called ‘parent’ tier, and then connected so-called ‘child’ tiers could be used to record the *properties* of the vocalisation. Looking at the specific example 'Voc 24' in Figure 2. below, it has been marked as a vocalisation, a consonant-vowel combination, attributed the communicative intention 'answering' and glossed with a word, 'there', and these properties would then be linked at extraction. ELAN also made it possible to extract multi-modal behaviours that overlapped temporally during extraction so that each modality could be focused on individually during coding (see Figure 2, 'Voc 25' below for an example of a co-occurring vocalisation, gesture and gaze). See section 2.4.2 for more detail on the extraction and further analysis of co-occurring behaviours.

Figure 2

Parent/child Tier Structure with Example from ELAN



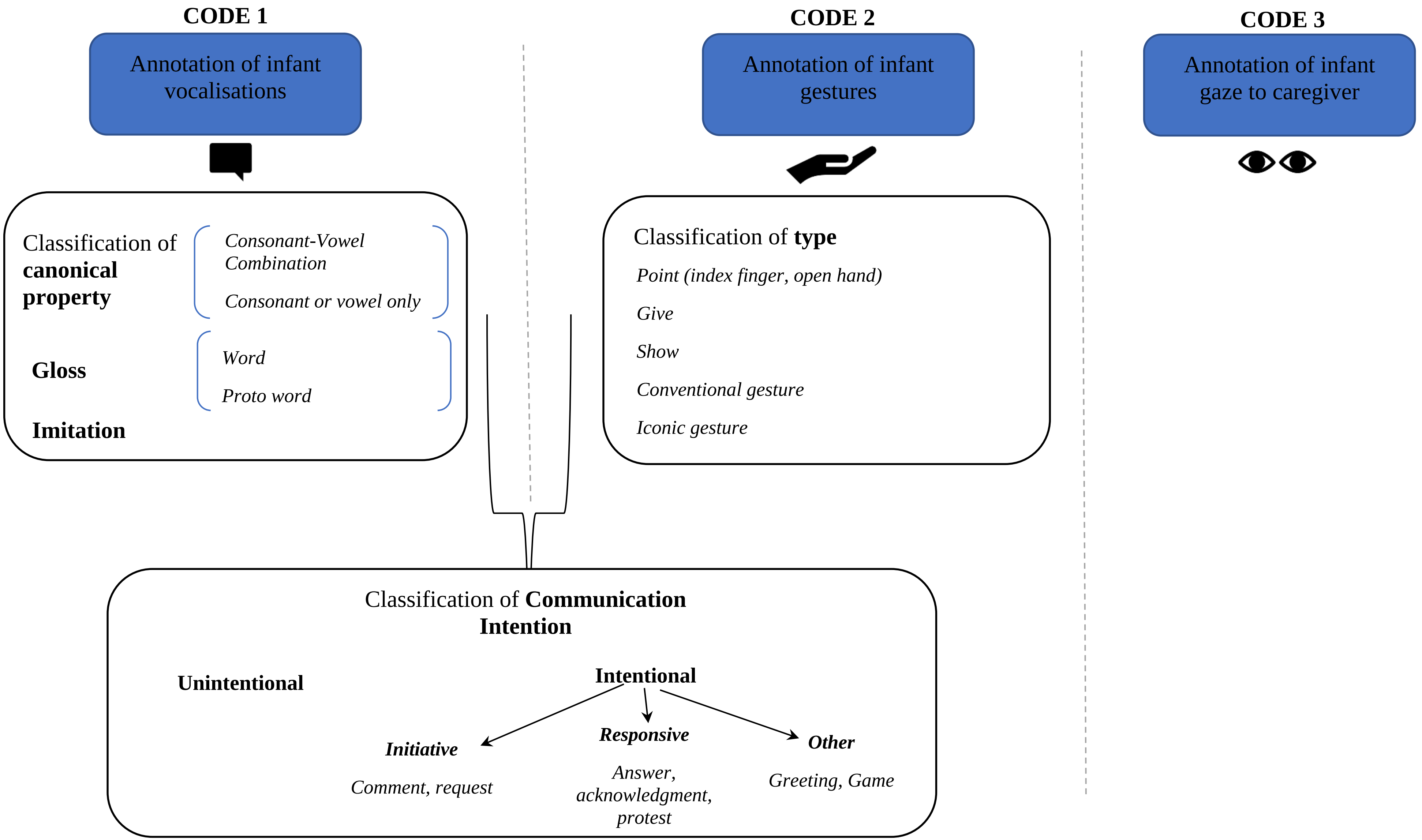
Note: Parent tiers are highlighted in green and child tiers representing properties are below each one. The example 'Voc 24' is highlighted in red, and 'Voc 25' in orange.

Each video was coded three times to allow for the researcher to focus on one parent behaviour tier at a time, either 1) vocalisations, 2) gestures, or 3) gaze (see Figure 3). It was felt that splitting modalities in this way would allow the researcher to concentrate solely either on the infants' hands for gestures, eyes for gaze, or the sound wave for vocalisations and past experience has shown this yields more accurate observations. Furthermore, because the principal measures of this thesis are the communicative intentions (CIs) *attached* to these behaviours, it was felt that using these behaviours as physical “hooks” would give coders a directly observable focal point on which to make a judgement regarding the infant’s intention. This method is endorsed by Bakeman and Gottman (Bakeman & Gottman, 1997), particularly for socially based schemes which by their very nature rely on some degree of inference.

The next sections go on to summarise the coding schemes for the coding of each behaviour in ELAN (see Appendix C for each scheme in full). There were four schemes in total, one for the coding of vocalisations, one for the coding of gestures, one for the coding of gaze, and a separate scheme for the coding of Communicative Intentions (CIs) of vocalisations and gestures. A separate scheme was created for the CIs as these were the most complex to code.

Figure 3

Structure of Naturalistic Video Coding



2.3.1 Vocalisations

2.3.1.1 Frequency. All speech-like vocalisations were coded for each participant video. Vocalisations were restricted to voluntary, non-vegetative sounds. Examples of types of vocalisations at 18 months include babble, cooing, vocal play (such as trills, raspberries), words and proto-words. Not coded as vocalisations were vegetative noises (such as burps, coughs, yawns), and involuntary fixed signals (such as crying and laughing), as per Oller, Eilers, Neal and Schwartz (1999). The duration of a vocalisation was coded from its exact frame of onset to the last frame in which the sound was audible. Two vocalisations were considered separate from each other if there was an audible silence of at least 200ms between them (Nathani et al., 2007), based on the 'breath-group' notion that vocalisations can be separated by audible gaps that allow for ingressive breaths (Oller & Lynch, 1992).

2.3.1.2 Canonical Property. For each vocalisation, one measure of canonical quality was determined and based on a scheme used by McGillion et al. (2017). Either the vocalisation was judged to be a consonant-vowel combination, featuring a canonical syllable containing at least one consonant and one vowel (CV, e.g., 'baby'), or was judged to contain only at least one vowel or a single consonant-like sound (non-CV, e.g. 'uh oh', or ‘sssss’). Here, consonants were defined as supra-glottal plosives, nasals, fricatives, affricates and liquids. The vowel category included all vowels and diphthongs, sounds on the syllabic boundary such as glides /w/ and /j/, as well as consonants that do not involve the vocal cords such as the glottal fricative /h/ and the glottal stop /ʔ/. An 'unclear' option was included for coding of vocalisations that were judged insufficiently audible to make it possible to determine a category (e.g. the infant was whispering, or in the infant and caregiver had talked over each other).

2.3.1.3 Gloss. Each vocalisation was then glossed for conventional meaning and a word or proto-word was transcribed where the infant was thought to have used some form of conventional language. Words were transcribed in the standard CHAT format (MacWhinney, 2000), with the addition of modern children's TV or toy characters, and a glossary of South Yorkshire dialect words (such as 'ta' for 'thank you'). To determine whether a vocalisation was a word or not, researchers attended to the infant's context and asked the following questions; was there a plausible target referent in close proximity to the infant? Was the infant engaged in an activity that the word could describe? Does the caregiver repeat the word? They were also asked to consider the phonological properties of the vocalisation; was there at least a partial match between the utterance and its conventional form? Did the child's utterance differ from its conventional form in ways typical of a child of this age (e.g. substituting a vowel or consonant)?

2.3.1.4 Imitation. Direct vocal imitations by the infant of a preceding caregiver vocalisation were marked using a scheme adapted from Masur and Rodemaker (1999) who used it to record instances of spontaneous imitations in naturalistic scenarios. In accordance with the scheme, vocalisations were coded as imitations if the infant's vocalisation had been clearly evoked by the caregiver's own (or an object’s) directly preceding utterance or sound and followed within 15 seconds after the caregiver's original. The imitated vocalisation had to bear some phonological resemblance to the original but did not have to be an exact match. Imitations could be categorised as words (IM W), as vocalisations (IM V), imitations of objects (IM O), imitations of something on the TV (IM TV). Furthermore, it was noted whether or not the imitation had been directly solicited (with the addition of S after the code, e.g. IM W [S]). Occasionally, it was noted by the author, imitation episodes turned into games/routines in which each half the dyad took a turn to repeat the imitated word (e.g., initial caregiver model 'ball', initial infant imitation 'ball', caregiver repetition 1 'ball', infant repetition 1 'ball'). Following Eckerman, Davis and Didow (1989), if the caregiver and infant continued the 'game' for longer than two turns each, the imitation was coded as having turned into a form of routinized/game embedded behaviour and thus coded IM G for each subsequent turn.

2.3.2 Gestures

2.3.2.1 Frequency & Type. All gestures made by the infant were marked and given a type from the options below.

2.3.2.1.1 Pointing. Criteria for coding a gesture as a point was informed by Matthews et al. (2012), in which the point was coded from the frame where the infant's arm was maximally extended, and the annotation ended at the point at which the infant began retracting their arm.

Two pointing types were taken from this scheme:

- Index Finger Points were characterised by the infant's index finger being visibly extended and apart from other fingers (which were curled back) in the direction of a referent. Alongside this, the infant's arm had to be fully or partially extended.
- Open Hand Points were characterised by the infant's hand(s) being visibly extended towards a referent. Alongside this, the infant's arm had to be fully or partially extended.

Two additional pointing categories were added by the author:

- Touch/Book Points were defined using the criteria above for an index or open hand point, excluding the criteria regarding arm extension, and including direct contact between the infant's fingers and a toy or the pages in a book. Although such touch/book points were excluded from Matthews et al. (2012), it was felt that doing so for the current purposes would unfairly exclude important gestural initiations and responses around popular and frequent play activities such as reading.

- Object Points are similarly defined as the above open hand points, but the infant is gesturing towards a referent but does not wish to relinquish the toy or object they are currently holding.

2.3.2.1.2 Giving and Showing. The give/show gesture was coded from the frame at which the infant's arm reached maximum extension, ending on the frame at which retraction began, or at the point the infant relinquishes the object they are giving/showing. Gives and shows were operationalised by the following mutually exclusive criteria (Cameron-Faulkner, 2014, 2014a; Carpenter, Akhtar, et al., 1998)

- Shows were characterised by the extension of the infant's arm, while holding an object, towards the caregiver (specifically towards the caregiver's face) so as to display the object (often, but not always with palms facing up).
- Gives were characterised by the extension of the infant's arm, while holding an object, towards the caregiver (specifically towards the caregiver's hands or body) so as to deliver the object (often, but not always with palms facing down).

2.3.2.1.3 Iconic Gestures. These gestures constituted any motoric action that served to reflect some aspect of a referent's character. Examples include the flapping of arms to represent flying, curving the arms and placing the hands under the armpits to represent the movements of a monkey, blowing a kiss. What these gestures have in common is that the movement is an imitation of a physical property of the intended referent (Cartmill et al., 2012)

2.3.2.1.4 Conventional Gestures. Contrary to iconic gestures, these are motoric actions that are largely arbitrary and do not literally reflect some aspect of the referent. Instead, their meaning is conveyed because it has become agreed upon by the community that the action is a symbol of x (therefore functioning like conventional labels). Examples include the nodding and shaking of the head to indicate affirmation and negation, clapping and waving for greeting (Cartmill et al., 2012).

2.3.3 Gaze

Every instance of infant gaze towards the caregiver's face was coded for each video. The beginning of a gaze was marked from the first frame that the infant's eyes were focused upon the caregiver's face, and the end marked at the last frame before the infant looked away.

2.3.4 Communicative Intentions

Each vocalisation and gesture was also coded for a speech act or communicative intention, and if appropriate was attributed to one of ten speech act categories adapted from the Coggins and Carpenter (1981) Communicative Intention Inventory (CII). There are numerous speech act taxonomies available, each varying in granularity (Cameron-Faulkner, 2014b). However, the CII was chosen for adaptation as the appropriate ‘mid-way point’ on a continuum of coding schemes that range from two to 60 categories (see Chapter 1, section 1.2.1 for more detail on various speech act taxonomies). We felt that the CII was appropriate for this study as the categories were mutually exclusive and exhaustive for the current 18-month dataset (Altmann, 1965). Furthermore, on a practical level, it was also felt feasible for the coder given the formal communicative behaviours to be coded alongside. The original speech act categories from the CII also collapse neatly into initiative (commenting, requesting) and responsive (answering, acknowledging) categories which was useful for making comparisons across cohorts in terms of initiating and responding to joint attention and for capturing individual differences as per Mundy et al. (2007). Commenting and requesting can also be used to look for individual differences across traditional declarative/imperative lines (Bates et al., 1975).

The communicative intention coding scheme (see Appendix C) cast an initial superordinate category (and subsequent subordinate categories) as questions as per Bakeman and Brownlee (1982), and recommended by Bakeman and Gottman (1997), to allow the coder to hone in on the correct category gradually. This started with an initial judgement as to whether the vocalisation or gesture was felt to carry a communicative intention at all. Intention at the superordinate level was operationalised by the infant and caregiver a) clearly engaged in joint attention (i.e. parent and child are jointly engaging with some toys, they do not have to have constant eye contact, but they are clearly attending to the context together), or b) attempting to establish joint attention (i.e. the child attempts to establish joint attention over a new object), and a set of behavioural markers included close physical or recent close physical proximity between infant and caregiver, recent gestural, vocal or verbal contact between infant and caregiver, or recent gaze from infant to caregiver within 3 seconds of the act.

If deemed intentional, a specific intention was attributed from the CII following the pathway depicted in Figure 4. As described above, each modality was coded separately on each video, with vocalisation, and accompanying communicative intention, coded first and separate to gestural intention. Once the coder came to code the gesture modality (and attribute communicative intention), if there were instances of vocal-gestural combinations (i.e. an index finger point and a word combined), they were encouraged to attend to the intention assigned to the vocal modality for context, but to attribute a different intention if appropriate as there were occasions in the data where the behaviours had co-occurred temporally by chance and were in reality distinct communicative acts.

Figure 4

Intention Coding Scheme Diagram

Is the vocalisation/gesture **communicative/is there a discernible communicative intention*** behind the vocalisation/gesture?

Yes

If **intentional*,** next decide whether the vocalisation/gesture is:

a) **Initiative***; initiated** by the infant independently of the caregiver's utterances.

b) **Responsive****;** a direct **response** to or acknowledgement of the caregiver's previous utterance.

c) **Other**; intentions that don't traditionally fit into the initiative or responsive divide.

No

2. If **unintentional**,** do not add a code to the tier, just leave blank.

IMPORTANT: If the vocalisation/gesture is a **repetition***** and a duplication of the intention, **you would also only code the first occurrence of the speech act** and leave the subsequent repetitions blank (adding REP to the Vocal or Gesture notes tier.

Uncodeable

3. ALL vocalizations where the child is **offshot (off camera) should be marked as uncodeable**. Offshot is defined as any part of the video where the infant's upper body (including head and face) is not visible and you therefore cannot see gestures and direction of gaze. Record this as Uncodeable in the Vocalisation Notes tier.

ALL gestures where you are unable to see the

infant's hands and therefore cannot tell

a) If **initiative***,** decide whether the vocalisation/gesture carries one of the following communicative intentions:

i) Comment on action
ii) Comment on object
iii) Request for action
iv) Request for object
v) Request for information

b) If **responsive****,** decide whether the vocalisation/gesture carries one of the following intentions:

i) Answer (to a direct question)
ii) Acknowledgement (a sign of agreement or compliance)
iii) Protest (a refusal)

c) If **other**, decide whether the vocalisation/gesture is one of the following:

i) **Greeting**
ii) **Game embedded behaviour**

Thus, the ten communicative intentions are presented in the next sections according to whether they are initiative, responsive or other:

2.3.4.1 Initiative. An initiative gestural or vocal speech act was one that had been initiated by the infant independently of the caregiver's preceding utterances or behaviour, and therefore did not relate to adjacent discourse.

A. **Comment (on an action or object).** A behaviour that serves to direct attention towards a referent or action simply to share attention to it; a form of 'showing' or 'telling' in which the infant does not expect or await a parental action as a response.
B. **Request (for an action, object or information).** A behaviour that serves to direct attention towards a referent or potential action that the infant is soliciting help to obtain or initiate; a form of 'asking' in which the infant does expect or await a parental action as a response.

It is important to note here that although we coded the comments and requests according to the action/object distinction (according to what the infant was commenting on or requesting), these were collapsed before analysis into broader comment and requesting categories since the object/action distinction was not pertinent to the questions set out in the subsequent chapters.

2.3.4.2 Responsive. A responsive gestural or vocal speech act served as a response to the caregiver's preceding utterances or behaviour, and therefore related to adjacent discourse.

A. **Answer.** A behaviour that functions as the infant's response to a request for information from the caregiver; any answer to question that requires specific information.

B. **Acknowledgement.** A behaviour that functions as a notice of agreement or compliance on the infant's part to the suggestion of a caregiver. Also, any instance of direct vocal imitation of a caregiver word or phrase.

C. **Protest.** A behaviour that functions as a notice of disagreement or non-compliance on the infant's part to the suggestion of a caregiver.

Other. These were added by the author following criticisms of the CII by Ninio et al. (1994) and could be initiative or responsive in nature.

A. **Greeting**. A behaviour that marks the new or continued presence or separation between an infant and their caregiver/another person/a toy.

B. **Game embedded behaviour**. A behaviour that marks the infant's appropriate turn in a routine, game or song.

2.3.5 Repetitions

Following the guidance on repetitions in the CII, an intentional behaviour that was repeated more than once and which referred to the same object or action was coded as having a speech act *on the first occurrence only*. For example, if the infant picked up a picture of a banana and said “banana” in order to comment on it and then went on to repeat “banana” twice, only the first utterance would be assigned an intention, with the latter two utterances merely a repetition of the same underlying intention. Coders were asked to mark repetitions by writing REP in the Vocal Notes tier so that these could be separated from the main data at a later point.

2.3.6 Offshot and Unavailability of Behaviours

2.3.6.1 Offshot. Options were also made available for the coding of periods where the infant was offshot of the two cameras. No data was extracted from sections of the video marked as offshot so as to avoid an unfair frequency skew in one or other modality. For example, if the infant was offshot, but still audible, continuing to code vocalisations might have led us to erroneously conclude that the infant was particularly vocal, while at the same time it was impossible to tell whether the infant was making concurrent gestures or gazing towards their caregiver.

2.3.6.2 Unavailability. There were also options unique to each modality that recorded when it had been impossible to tell whether the infant was vocalising, or gesturing, or gazing regardless of whether the infant had been completely offshot or not. For example, instances of gaze unavailable were recorded when it was impossible to determine the direction of the infant's gaze, for example, due to the position of the infant or caregiver's head. This category did not rely on being able to see the infant's eyes, for example, there were some instances where the infant's eyes were occluded but the position of the head meant that they were looking at the floor. However, if that same infant had raised their head, but it was impossible to ascertain whether the direction of gaze was to the caregiver, this would be deemed gaze unavailable. Similarly, gesture unavailable, was used for each instance that the infant's arms and head were out of shot, so that it was possible that they had been pointing, nodding their head etc, out of shot. Similar to period of time offshot, data from time periods marked as Unavailable across all modalities was not extracted so as to not artificially inflate one modality over another.

2.3.7 Reliabilities

In order to evaluate inter-rater reliabilities, a second researcher was trained to code frequencies of the following behaviours; vocalisations (including CV/non-CV vocalisations, vocal imitations, words), communicative intentions of vocalisations (comments, requests, answers, acknowledgements and protests), and episodes of gaze to caregiver face. Frequency of vocalisation behaviours was coded by the second researcher for 9% of participants (n = 10), and 8% of participants for gaze behaviours (n = 9).

Intraclass Correlation, ICC 3,1 (McGraw & Wong, 1996) was performed using a two-way mixed model (type = consistency, and form = single measures). Interrater agreement was generally high (excellent/good) for canonical property of vocalisations (r = .93), words (r = .94), and vocal imitations (r = .92), and also for the coding of infant gaze to caregiver's face was also high (r = .97). Interrater agreement for the communicative intentions of vocalisations was more varied, but still good overall (vocal comments, r = .78; vocal requests, r = .95; vocal answers, r = .77; vocal acknowledgements, r = .94). There was a lack of agreement for the coding of vocal protests (a behaviour that functions as a notice of disagreement or non-compliance to the suggestion of a caregiver, r = .39). This appeared to be due to the difficulty of differentiating intentionally communicative protests from unintentionally produced signals that appear to be protests (i.e., whining, screaming) and so a decision was made at this point to exclude protests from further analysis.

2.4 Data Extraction and Coding of Coordinated Behaviours

The ultimate goal of the extraction and processing of the naturalistic video data from ELAN was to sort each coded communicative act into one of three mutually exclusive datasets:

1. Solo unimodal vocalisations
2. Solo unimodal gestures
3. Vocal-gestural combinations

It was felt this would make the cross-referencing of both intentional and formal properties easier and allow us to apply an automated algorithm to determine frequencies of co-ordinated acts (i.e., vocal-gesture combinations) post-hoc and without adding a fourth coding wave to the videos to look at combinations. This latter procedure was effective, time saving and reduced human error.

2.4.1 Datasets 1 and 2: Extracting Basic Frequency Data for all Vocalisations and Gestures.

To extract dataset 1, solo unimodal vocalisations, a query was run across all 104 videos in ELAN which extracted basic frequency data for each vocalisation (and accompanying properties). Figure 5 shows an example of the output, demonstrating vocalisations as linked with participant number in column H and properties in Column B. A unique identifier was created for each individual vocalisation (see Figure 5 column A) by combining participant number, a behavioural code (V for vocalisation, G for gesture), and the annotation start time. This would allow us to spot and remove any duplications at a later point. The same process was repeated for dataset 2, solo unimodal gestures.

Figure 5

Example of extracted frequency data for vocalisations

	A	B	C	D	E	F
1	ID creation	Annotation	Annotation Begin Time	Annotation End Time	Annotation Duration	Hit Position In Tier
2						
3	[illegible]_V_59145	Voc 01 non-CV yeah. answering	59145	59635	490	1
4	[illegible]_V_61280	Voc 02 CV doggy dog@o doggy. answering	61280	63795	2515	2
5	[illegible]_V_66990	Voc 03 CV woof. IM W acknowledging	66990	67680	690	3
6	[illegible]_V_79940	Voc 04 CV answering	79940	82460	2520	4
7	[illegible]_V_91420	Voc 05 CV answering	91420	92190	770	5
8	[illegible]_V_94445	Voc 06 non-CV yeah. acknowledging	94445	95575	1130	6
9	[illegible]_V_105475	Voc 07 CV ball. comment on object	105475	106555	1080	7
10	[illegible]_V_109920	Voc 08 non-CV yeah. answering	109920	110370	450	8
11	[illegible]_V_113165	Voc 09 CV ball. comment on object	113165	114095	930	9
12	[illegible]_V_116890	Voc 10 non-CV	116890	117130	240	10

2.4.2 Dataset 3: Extracting and Analysing Co-occurring Vocalisations and Gestures

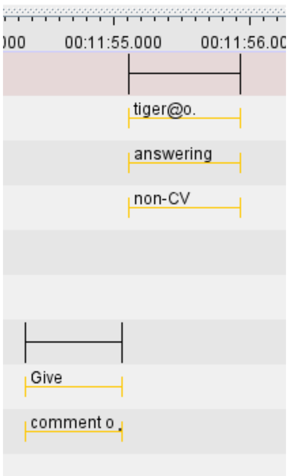
In order to generate dataset 3, vocal-gestural combinations, five queries were run across the videos to extract behaviours that had co-occurred temporally. These queries extracted instances where (1) vocalisations had occurred 1000ms before gestures, (2) vocalisations and gestures had overlapped in time, (3) vocalisations had occurred 1000ms after gestures, (4) gestures had occurred 1000ms before vocalisations, (5) gestures had occurred 100ms after vocalisations. A temporal window of 1000ms window either side of the behaviour was chosen to mark potential combinations both for gaze, and for vocal-gestural combinations as this had also been chosen by Matthews et al. (2012), and Wu and Gros-Louis (2014). However, the temporal window has varied across studies in the past, possibly as due to technological constraints that did not allow for frame by frame analysis as did ELAN (Donnellan, 2017). Once extracted to Microsoft Excel, the results of these five queries were each given a unique identifier according to the procedure above to aid data linkage and deduplication.

This list of potential vocal-gesture combinations was then cross-referenced with datasets 1 and 2 (solo unimodal vocalisations and gestures), and any occurrences where the unique identifier matched were highlighted. Those vocalisations or gestures highlighted as potential vocal-gesture combinations were then removed from the solo datasets. These were pasted into another spreadsheet which became our initial dataset 3, a list of temporally occurring vocal-gesture combinations (plus their properties) which had been removed from the solo sheets.

2.4.2.1 Differentiating True Vocal-Gesture Combinations. The next step was to perform a check as to whether the behaviours had actually co-occurred meaningfully (and therefore represented a true combination), or whether they had occurred temporally but were in reality distinct acts. In Figure 6, the infant gestures to give an object to their caregiver in order to share attention to it, and in the meantime is asked by the caregiver 'what is it?'. They answer immediately by imitating a tiger's roar. The two behaviours temporally overlap and so had been included in the ELAN output for co-occurrences; however, they are clearly intentionally and functionally separate acts, one functions to initiate joint attention to the tiger, and the other to respond to a caregiver's question.

Figure 6

Example of temporally coordinated behaviours that do not match intentionally



To differentiate between true vocal-gesture combinations, defined as instances where behaviours matched intentionally, or behaviours that shared "pragmatic function" as per Igualada et al. (2015), and those that had occurred temporally but were intentionally discordant, an algorithm was developed and applied to dataset 3 to check for a match between communicative intentions of both behaviours. Since the principal measure of the thesis was proportions of communicative intentions, it was felt that an intention first approach to discriminating between these was appropriate.

Our intention matching algorithm also had to account for two types of temporally co-occurring behavioural mappings in the data as demonstrated by Figures 7 and 8 below. The first, (a) was a simple 1:1 co-occurrence of a single gesture and a single vocalisation (comprising a single row in Microsoft Excel). In Figure 7, three simple 1:1 behavioural mappings are displayed for participant 1, for example vocalisation 35 and gesture 12 represent a temporally occurring 1:1 co-occurrence of a vocalisation and a gesture (here the infant vocalises ‘amazing’ to comment on an object, while giving the object to the caregiver, again in order to share attention, in this instance there was no obvious instrumental intent other than for the caregiver to register the object)

Figure 7

Illustration of simple 1:1 mappings of temporally co-occurring vocalisations and gestures

	D	AB	AM	AN	AO
1	Vocalisation	Gesture	P	VOC UNIQUE IDENTIFI	GEST UNIQUE IDENTIFIER
19	Voc 35 CV amazing. comment on object	Gesture 12 Give comment on object	1	V_245670	G_245930
20	Voc 36 CV a bit. comment on object	Gesture 13 Give comment on object	1	V_267190	G_267495
21	Voc 37 CV bit. comment on object	Gesture 14 Give comment on object	1	V_272040	G_271615

Figure 8

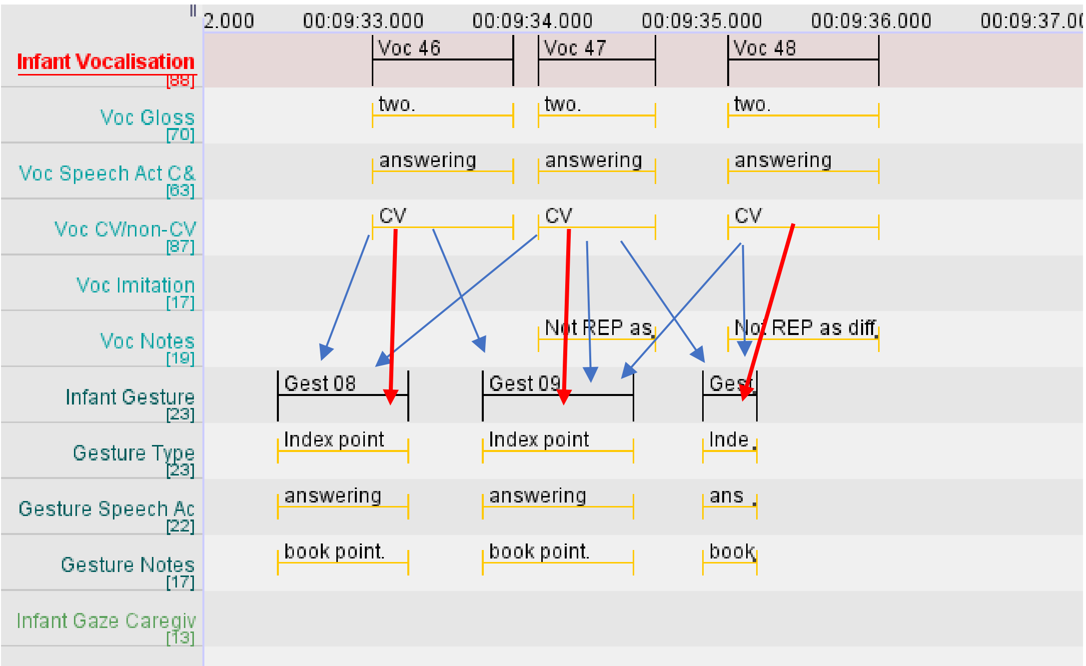
Illustration of complex mappings of temporally co-occurring vocalisations and gestures

	D	AB	AM	AN	AO
1	Vocalisation	Gesture	P	VOC UNIQUE IDENTIFI	GEST UNIQUE IDENTIFIER
13	Voc 23 CV baby. comment on object	Gesture 8 Give comment on object	1	V_169510	G_170675
14	Voc 24 CV comment on object	Gesture 8 Give comment on object	1	V_170630	G_170675
15	Voc 25 CV xxx@b baby comment on object	Gesture 8 Give comment on object	1	V_172110	G_170675
16	Voc 26 CV chicken IM W acknowledging	Gesture 9 Give comment on object	1	V_184645	G_184470
17	Voc 31 CV oh no comment on object	Gesture 10 Index point comment on object	1	V_212850	G_214145
18	Voc 32 CV there. comment on object	Gesture 10 Index point comment on object	1	V_214810	G_214145

In contrast, the second type was (b) instances of behaviours that instead of being linked 1:1 with another behaviour as above, actually ran across three or four behaviours at a time. Figure 8 displays a complex mapping where Gesture 8, where the infant is using the give gesture to share attention to an object, co-occurs temporally with three separate vocalisations (vocalisations 23, 24 and 25). A formula that applied a simple intention matching function to each row would inflate the number of vocal-gesture combinations from one to three despite there having been only one gesture. This in turn risked situations as depicted in Figure 9 where behaviours occurred so closely in time that that a simple algorithm would falsely double- and even triple-, count the number of vocal-gesture combinations and artificially inflate the frequencies. In Figure 9, a simple intention mapping algorithm would count a total of seven combinations due to multiple behaviours overlapping quickly in time, occurring one second before, and one second after each other. This parsing would see each vocalisation being linked with two or more gestures (as indicated by the blue arrows). In reality, the more appropriate coding of the acts would be to distinguish just three separate acts (as indicated by the red arrows) so we needed a rule that would be more discerning in these scenarios which were very common across dataset 3. It was decided that the algorithm would also encode a rule that stipulated that if a behaviour had been used in a preceding vocal-gesture combination, it could not be used again, and the individual behaviours retained for the solo vocalisation and gesture sheets.

Figure 9

Example of erroneous inflation of combinations from ELAN extraction



Description: Blue arrows show the vocal-gesture pairings as identified by ELAN extraction queries on behaviours that overlap temporally or occur within 1000ms of each other. Red arrows show the vocal-gesture combinations that more accurately reflect the infant's intentions.

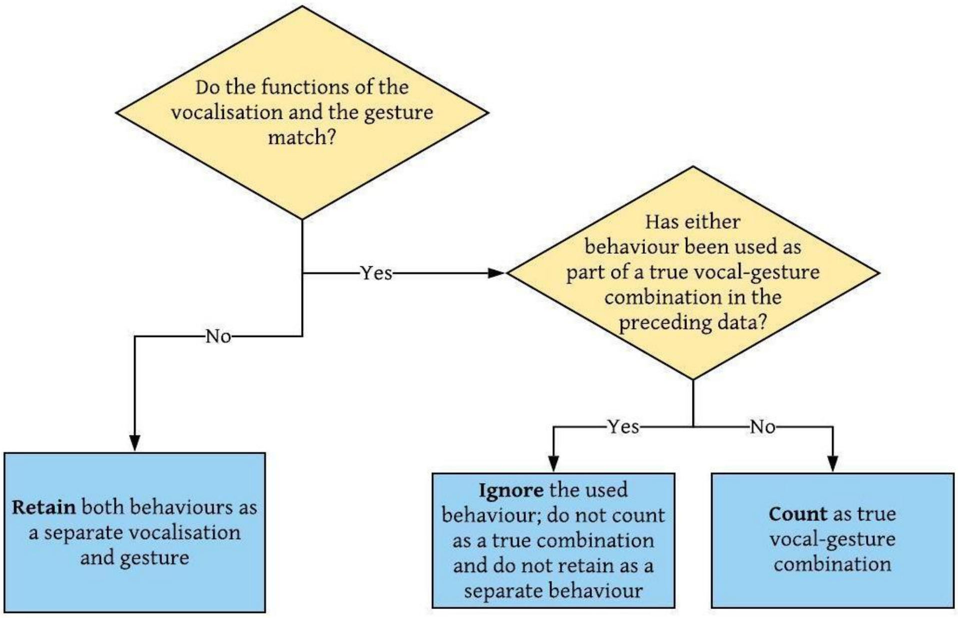
Figure 10 depicts the rules of the final algorithm as applied to the dataset as an Excel formula. It first checked for an intention match between behaviours row by row, then checked that a particular behaviour (identified using the unique number) had not been used in a combination in the preceding five rows. The first five behaviour mappings in the sheet had to be coded manually by the author due to the iterative nature of the formula (simply, there were no preceding rows to analyse). The application of the algorithm marked whether a mapping was a true vocal-gesture combination and therefore could remain in dataset 3, or whether the behaviour did not match intentionally and therefore had to be removed and added back to datasets 1 or 2 as a solo unimodal vocalisation or gesture. A manual check of 15% of the data

(n = 16, selected randomly) on both 1:1, and complex rules yielded a 100% match between manual coder (the author) and the algorithm on differentiating true vocal-gesture combinations based on the intention matching rules below.

The behaviours identified as solo vocalisations or gestures (and not part of a true combination) using the process above were then added back to the solo spreadsheets. A check for duplications was run using the unique identifier given to each act, and any duplications removed. Furthermore, any acts that had been identified as repetitions were removed as per the original Coggins and Carpenter scheme (1981).

Figure 10

Illustration of the vocal-gesture combination processing rule



2.4.3 Marking Gaze Co-ordinated Behaviours

As outlined above, all properties of the vocalisations, gestures and vocal-gesture combinations had been extracted together and were linked in the datasets (i.e., communicative intentions, words, gesture types were linked with their behaviour), so that frequencies could be calculated as needed. However, instances of gaze coordination with any other behaviours had to be extracted separately and cross-referenced across the three datasets. Six queries were run to extract instances where (1) a vocalisation and gaze to caregiver overlapped, (2) a gaze to caregiver occurred 1000ms before a vocalisation, (3) a gaze to caregiver occurred 1000ms before a vocalisation, (4) a gesture and gaze to caregiver overlapped, (5) a gaze to caregiver occurred 1000ms before a gesture, (6) a gaze to caregiver occurred 1000ms before a gesture. Each behaviour with a temporally coordinated infant gaze to caregiver was given a unique identifier (as defined in the procedure above) and a VLOOKUP was performed on each of the three datasets (using the unique identifier) to indicate where behaviours had co-occurred with gaze.

2.4.4 Cleaning of Words and Calculation of Word Types

To obtain a measure of conventional language use across the videos, it was necessary to separate true words, protowords and idiosyncratic vocalisations across all vocalisations and vocal-gesture combinations. All protowords (i.e., exclamations, animal noises, vehicle noises etc.) had been prefaced with @ as per CHAT guidelines and were easily located within datasets and separated from the true word count for each participant. Each participant’s true word counts were then put through an online unique word count calculator (https://planetcalc.com/3205/) to ascertain a total of word types across the video as well as tokens (the latter not giving as accurate a picture of vocabulary as much as infant volubility).

2.4.5 Conversion of Frequencies to Proportions

Finally, the three spreadsheets; solo unimodal vocalisations, solo unimodal gestures and vocal-gestural combinations were a mutually exclusive reflection of the three modalities and could now be used to provide frequencies of behaviours and their intentional and formal properties for each participant. However, since the length of video had varied from participant to participant (for example, due to caregivers requesting video being stopped), a proportion of the communicative intentions per minute was calculated and used for analysis. A proportion was preferred, rather than implementing a cut off for each video (Mean Video Length = 13 minutes, 21 seconds; Range = 7 minutes, 40 seconds – 18 minutes) so as to maximise the data available for each infant.

Data from the three mutually exclusive datasets were collated for statistical analysis, and a descriptive summary and correlational analysis is presented in the next chapter.

3. Individual differences in expression of communicative intentions at 18 months; interrelations and concurrent associations with formal language skills

Abstract

In Chapter 2, a methodology was described for the creation of a baseline dataset which captured a naturalistic snapshot of the emerging communicative and pragmatic abilities of a cohort of 18-month-olds from the Yorkshire and Midlands region (*N* = 104). The current Chapter provides a descriptive analysis of this expressive communicative ability at 18 months and establishes early individual differences in the cohort, both in rate of expression of various communicative intentions (comments, requests, answers, acknowledgements), in modality (vocalisations, gestures, vocal-gesture combinations and gaze), and concurrent vocabulary size. The possible architectural interplay between various communicative intentions and formal language skill in early infancy is still not fully understood and so the present work also aimed to establish to what extent these skills co-vary in the sample through correlational analysis. Our results show significant positive but weak intercorrelation between all of the intentions, except for answers and acknowledgements which showed significant moderate intercorrelation, and requests and acknowledgements which showed weak non-significant intercorrelation. All communicative intentions showed significant weak to moderate correlation with concurrent formal language skill, except for acknowledgements. This suggests that there is set of related but multi-factored pragmatic skills and motivations that are somewhat intertwined with vocabulary development skill during infancy.

3.1 Introduction

Like adults, when young children communicate something, they also intend to *do* something. That is, they are able to use communication to intentionally effect change in those around them and in their physical environments. By 18 months, despite a limited grasp of conventional language, the typically developing infant is operating with a toolkit of communicative behaviours that they use to convey a variety of different intentions in their everyday interactions. Even while their vocabularies are relatively limited (Fenson et al., 1994), they are able to employ a range of formal tools such as idiosyncratic vocalisations and prosody (Esteve-Gibert & Prieto, 2013), gestures (Franco & Butterworth, 1996a), vocal-gesture combinations (Cameron-Faulkner, 2014a) and eye contact (Bates et al., 1975), for a variety of *functional* purposes known as speech acts. For example, requesting and commenting on objects and actions, and asking and responding to questions (Bates et al., 1975; Carpenter, Nagell, et al., 1998; Carpenter et al., 1983; Snow et al., 1996).

However, variation is a natural feature of virtually all facets of the human existence (Kidd et al., 2018), and the early development of communication is no exception. Individual differences are pervasive and well established across several linguistic domains (Bates et al., 1995; Bornstein & Putnick, 2012), and particularly well researched in the lexical domain. For example, early individual differences in vocabulary growth are stable and persistent well into adolescence and beyond (Rose, 2010; Scarborough et al., 2001), and can have substantial adverse impact on life trajectories, with regard to literacy (Snowling & Hulme, 2012), later academic achievement (McCormack et al., 2011), employment opportunities (Johnson et al., 2010) and general wellbeing (Dockrell et al., 2012).

Surprisingly, comparatively little is known about the nature of early individual differences at the socio-pragmatic or functional level, or within our early ability to *use* communication to intend things (Ninio & Snow, 1999; O'Neill, 2014). This is despite the posited centrality of pragmatics to human communication generally (Levinson, 2019; Tomasello, 2010; Wittgenstein, 1953) and to language acquisition proper (Bates, 1976; Bruner, 1983; Tomasello & Farrar, 1986), and despite the similarly adverse downstream effects observed for early pragmatic deficits as for vocabulary differences. For example, we know that it is difficulty in using pragmatics, and not in structural language skill, as early as 4 years old that is a stronger predictor of behavioural problems in otherwise typically developing children (Ketelaars et al., 2010; Mackie & Law, 2010). Furthermore, pragmatic deficits are linked to academic challenges at school (Barbarin & Jean-Baptiste, 2013; Troia, 2011), peer victimization (Conti-Ramsden & Botting, 2004; Murphy et al., 2014), and with problems in interpreting oral and written language in general (Carpendale & Lewis, 2004; Vazquez et al., 2013; Westby, 1998).

Work on early pragmatic ability has tended to focus on establishing universals in types or sequences of early pragmatically motivated behaviour, usually through experimental paradigms designed to minimise individual differences (e.g., Behne et al., 2012). This is crucial to our understanding of typical developmental trajectories. However, given the importance of pragmatics to communication and later life outcomes, it is essential that we also look to establish exactly how early meaningful differences emerge during infancy and how these may interrelate to potentially affect the life course.

The following sections present a detailed overview of the typical development of intentional communication between 0 and 18 months, including the range of intentions infants come to express and how. We then review several notable studies that have specifically looked to establish individual differences in early use of various socio-pragmatics skills, from initiating and responding to joint attention, to the use of speech acts (Carpenter, Nagell, et al., 1998; Mundy et al., 2007; Snow et al., 1996). We will show how this work is piecing together a picture of how these socio-pragmatic skills may ‘hang together’ in ontogeny, whether early socio-pragmatic abilities constitute a homogenous group with similar underlying mechanisms, and whether there is evidence they may form a domain separable to formal language, before highlighting several methodological gaps that this chapter aims to address.

3.1.1 What Infants Intend: The Development of Speech Acts

A useful way to chart the development of expressive communicative intention in infancy is to explore the infant's emerging ability to engage in speech acts beginning around the end of their first year (Cameron-Faulkner, 2014b). Recall from Chapter 1 that speech acts are the various intentions and propositional goals underlying our communicative behaviours. For example, if I say "oh, wow" whilst pointing to an unexpected firework in the sky, I am intentionally directing your attention to share in or comment on a novel event (see Chapter 1, section 1.2 for more detail). It is also helpful to characterise the infant's typical transition through three developmental stages based on the three aspects that all human utterances share according to speech act theory, namely the locutionary (the speech/physical act of uttering, i.e. "oh wow"), the illocutionary (the intention behind the behaviour, i.e. "look at that firework", this *is* the speech act (Levinson, 1983)), and the perlocutionary (the effect on the listener, i.e. you follow my point to the sky and say "very pretty") (Austin, 1962). Bates et al. (1975) inverted these stages and applied them to the infant's journey to conventional language and the following sections summarise what and how infants intend at each phase.

3.1.1.1 The Perlocutionary Phase. Infants are unlikely to be engaging in intentional speech acts in the perlocutionary phase from birth to 9 months, during which their behaviours often have an effect on the listener (i.e., the infant cries and the caregiver feeds), but the behaviour has not been produced *intentionally* by the infant to induce the effect (Bates et al., 1975). However, during this period, infants display a precocious motivation to use and attend to the types of social cues that underlie intentional speech act use. Firstly, this amounts to series a of biases and expectations during early interactions with their caregivers. For example, infants show a very early preference for eyes and direct eye contact (Batki et al., 2000; Farroni et al., 2002), they prefer the slow and exaggerated qualities of Infant Directed Speech (Cooper & Aslin, 1990; Fernald & Mazzie, 1991; Saito et al., 2007), and they expect contingency and reciprocity from their caregivers (Henning & Striano, 2011; Murray et al., 1985; Toda & Fogel, 1993; Tronick et al., 1979). Secondly, the infant displays a burgeoning ability to take behavioural turns in routines (i.e., 'peekaboo' games (Bruner, 1983)), to understand their role in the temporal structure (i.e. knowing when to be passive and when to be active (Trevarthen, 1979)), and to use these 'protoconversations' to exchange affect with their caregiver (Bloom et al., 1987; Casillas, 2014; Locke, 1993). Thirdly, they show a rudimentary understanding that communicative behaviours carry social and emotional currency (Field et al., 1988; Markova & Legerstee, 2006; Stern et al., 1985), as well as informational value. For example, at 6 months, there is evidence that infants understand that speech has an information transferring property and that it carries intentions in the abstract. By showing preference for an experimenter selecting an object when accompanied by a nonsense word over a cough, they demonstrate a sort of knowing 'that' speech has a function, before knowing 'what' that function is (Vouloumanos et al., 2014). During this period, they are also learning to control their own ability to vocalise to *express* emotional content. Even as young as 3-4 months, infants have been shown to use a set of non-vegetative vocalisations (squeals, vowel-like sounds and growls) outside of the fixed signals domain (i.e., crying and laughter) to express affect (Oller et al., 2013). They do so *flexibly* so that the use of these 'protophone' vocalisations varies randomly to portray both positive and negative affect. They also show capacity to understand that their vocalisations can affect others and elicit responses (Donnellan et al., 2020; Goldstein et al., 2009).

By acting with these early prosocial biases, infants are unintentionally encouraging their caregivers to ascribe intention and meaning to these initially perlocutionary behaviours (Keller & Schölmerich, 1987; Miller & Lossia, 2013; Snow, 1977), and they are eliciting caregiver behaviours that help scaffold their learning (Albert et al., 2018; Bloom et al., 1993; Henning et al., 2005; Lavelli & Fogel, 2005).

3.1.1.2 The Illocutionary Phase. The precocious and gradual understanding of the structure and value of communication that occurs during the perlocutionary stage is argued to set the stage for the emergence of speech acts proper as infants transition to the illocutionary stage at the end of their first year. During this period, infants appear to engage in communicative behaviours with an illocutionary force, that is in non-verbal behaviours that affect the listener's behaviour, but this time the infant is said to have intentionally done so (Bates et al., 1975). What is thought to underlie this developmental leap is a suite of socio-pragmatic developmental milestones reached at around 9 – 12 months (Tomasello, 2010). A first set of skills enable the infant to reason *about* others' behaviours, understanding that others have goals (Behne, Carpenter, Call, et al., 2005), that they pursue them intentionally (Moll et al., 2006), and have knowledge states of their own (Onishi & Baillargeon, 2005). A second set allow the infant to experience things *with* others. For example, during this period, infants engage in triadic joint attention for the first time (Bakeman & Adamson, 1984), moving from interacting dyadically with either a caregiver or an object *independently*, to integrating all three entities triadically. Triadic joint attention provides a context for the creation of mutual knowledge (Moll et al., 2008) and for the construction of *shared* goals (Warneken & Tomasello, 2007), and crucially allows for the emergence of speech acts.

In their landmark longitudinal analysis of three Italian speaking infants, Bates et al. (1975) demonstrated that around 10 months, infants begin using gesture to convey two fundamental speech acts, the protoimperative and the protodeclarative, as manifestations of their newly developed intentional and joint attentional understanding. The protoimperative is the infant's intentional use of a listener for some instrumental purpose (i.e., obtaining an object), whereas the protodeclarative is the intentional use of an object or event to obtain and share in the listener's attention. To demonstrate the gradual development of the protodeclarative for example they recorded one of the infants, Carlotta initially 'showing off' and blowing raspberries to her caregivers in a dyadic scheme involving attention regulation between the self and others. This progressed to Carlotta showing objects to caregivers, presumably to recreate the positive feedback she gained from 'showing off' herself. Eventually at 12 months, Carlotta started to point to distal objects to direct attention, alternating her gaze between the caregiver and the object, successfully integrating three elements in joint attention (the self, the object, the caregiver) and crucially allowing distance between herself and the referent. For Werner and Kaplan (1963) this represents a cognitive distancing between the self and referents which is essential to development, and this developmental continuum from the proximal to the distal was replicated empirically by Carpenter et al. (1998).

Research suggests that protodeclarative gestures emerge earlier than protoimperative gestures (Carpenter, et al., 1998; Snow et al., 1996), and the earliest gestures produced in the protodeclarative motive are thought to be holdout gestures whereby the infant holds out an object in order to show it and share attention to it (Bates et al., 1975; Boundy et al., 2019). Declarative pointing emerges slightly later at 12 months (Liszkowski et al., 2004a), and holdout gestures are now thought to be precursors to pointing (Cameron-Faulkner et al., 2015). These early declarative gestures appear to have to have two purposes for the infant (1) to obtain and share in the listener's attention, and (2) to elicit some feedback from the listener. This is clear from experiments that demonstrate infants are not satisfied in experimental conditions whereby their gesture has not clearly achieved triadic joint attention (bought about by the experimenter either attending only dyadically to either the infant or object alone, or by showing disinterest). In these latter conditions, infants were much more likely to repeat their gestures and use repair behaviours such as gaze and vocalisations suggesting they were dissatisfied that they had not directed the attention of their interlocutor and that their original goal was to communicate declaratively (Boundy et al., 2019; Liszkowski et al., 2007). Protodeclarative pointing has been further divided into two distinct social functions based on context, (1) to provide information (usually lacking to the listener), and (2) to express and share an attitude towards an object in joint attention (Liszkowski et al., 2004b; Liszkowski et al., 2006), although Southgate et al. (2007) suggest that rather than a declarative motive, pointing is purely interrogative, and a way for the infant to acquire information, rather than to connect with others. Despite this, for Tomasello (2010), the protodeclarative is evidence that infants can operate with full Gricean communicative intention (that is, with both an informative intention, ‘I wish you to know this’, and a potentially nested comunicative intention, ‘I wish you to know that I intend for you know this’). The feasibility of infants having developed such potentially complex cognitive and metarepresentational understanding is subject to debate (see Chapter 1, section 1.2.2), However, identifying the underlying psychological structure of infants’ intentions is not the focus of the current chapter which instead aims to provide a naturalistic picture of the types of speech acts infants appear to express and how these interrelate, and not to contribute to the debate about underlying intentional systems.

In contrast with protodeclaratives, protoimperative gestures have been viewed as less social in function, less about connecting with others and sharing joint attention and more about using an interlocutor to obtain something for the self (Brinck, 2004; Camaioni, 1993; Gómez et al., 1993). Intuitively, it may appear to be logical that protoimperatives would precede protodeclaratives in development due to the supposed lower-level instrumental function involved. However, the opposite has been shown to be the case in longitudinal studies (Carpenter, Nagell, et al., 1998; Franco & Butterworth, 1996a, 1996b; Snow et al., 1996). Furthermore Grosse et al. (2010) found that infants at 18 months under experimental conditions pointed with the imperative motive to an obtain an object and upon acquiring the object they desired (thus having fulfilled the instrumental function of the imperative), still repaired a perceived breakdown in communication, for example, if the experimenter gave the infant the desired object 'by accident' while looking at another. This suggests that the infant is not satisfied that the intention has been fully signalled if they achieve the instrumental goal (of getting the object), but it has been misunderstood by the recipient (see also Shwe & Markman, 1997).

Much of the literature on the emergence of communicative intention comprises studies on gesture alone. However, recently attention is turning to how infants signal intention in the vocal modality. Papaeliou and Trevarthern (2006) argued that 10-month-olds can use canonical babbling intentionally, demonstrating that 'social' communicatively intentional vocalisations could be distinguished from 'private' self-regulatory vocalisations by pitch and length alone (with communicative vocalisations being higher pitched and shorter). Esteve-Gibert and Prieto (2013) built on this work, finding that by 11 months, intentional and non-intentional vocalisations could be differentiated with the latter being of a shorter duration with a wider pitch. They also found deliberate differential use of acoustic properties to mark more specific pragmatic functions, namely requests and expressions of discontent displaying wider pitch and longer duration than statements or responses. Even initially vegetative sounds such as laryngeal grunts, which would early on accompany an infants' motoric effort or focal attention, can be used as a marker of communicative intention at around 12 months (McCune et al., 1996).

Even rarer is work looking at coordination of vocalisations and gestures, but what exists is illuminating. For example, Cameron-Faulkner (2014a) studied the production of protoimperatives, exploring the *interaction* between gesture and the prosody of accompanying vocalisation. She found a shift from reaching gestures accompanied by rising terminal pitch contours to points accompanied by non-rising contours and argues that intonation can function as a placeholder for speech acts before the development of conventional language to signify intention. This aligns with theories of continuity between prelinguistic and linguistic ability wherein illocutionary acts expressed non-verbally come to be substituted by conventional forms (Bates, 1976; Bruner, 1975; Ninio & Snow, 1999). Others posit discontinuity between these phases (Dore, 1975) arguing that words have an underlying mechanism that is specifically referential, however what is important for this Chapter is that the two are closely intertwined.

3.1.1.3 The Locutionary Phase. At around 12 months, infants acquire their first words and enter the locutionary phase during which the infant expresses intention using conventional language in the place of gesture or idiosyncratic vocalisation (Bates et al., 1975). First words signal a widening of the infant's repertoire of communication intentions beyond the protodeclarative and protoimperative as demonstrated by the work of Snow et al. (1996). They conducted an in depth large-scale longitudinal analysis (N =100) of the development of speech acts from 14 to 32 months based on naturalistic data (video of semi-structured play between infant and caregiver) and used a speech act coding scheme they developed to address shortcomings they saw in the original schemes originating in the 1970's (Bates et al., 1975; Dore, 1975; Greenfield & Smith, 1976; Halliday, 1975) which they felt were too narrow in scope and sparse in operational guidance. The abridged version of the Inventory of Communicative Acts (the INCA-A; Ninio et al., 1994; Ninio & Wheeler, 1984) is a comprehensive, fine-grained taxonomy of > 60 speech act categories which can be used to code at the utterance level from infancy through to childhood (and therefore capture continuity of development from illocutionary to locutionary period). The INCA-A also offers analysis across a higher discourse level called the interchange level which groups individual utterances into what higher level social scenario they are attempting to bring about when combined (i.e., negotiating activity). However, as this chapter is concerned with intentions at the utterance level, we report only the authors' findings on speech act types.

As expected, between each age group, they found leaps in the average number communicative attempts per minute, the number of speech act types produced, and the proportion of communicative attempts that were interpretable as having a speech act. On average, at 14 months, infants produced a range of 3.79 speech act types (*SD* = 2.50). The most frequently used speech act types were in the declarative motive, namely the marking of object transfers and events, declarative statements, and repetitions. The authors remarked that this contradicted what they had expected to find which was that responsive speech acts (such as answers) would emerge prior to initiative speech acts that require the direction of attention. Furthermore, their findings align with a host of studies showing that declarative motive emerges before the imperative (Carpenter, et al., 1998). However, it is important to note that less than half of the communicative attempts made per minute at 14 months (*M* = 4.57, *SD* = 2.60) were interpretable as having a speech act and there was much variation (see section 3.1.2.1 below). By 20 months, the interpretability of all communicative attempts made per minute (*M* = 7.91, *SD* = 2.80), had risen to 79%, and infants produced on average 10.50 speech act types (*SD* = 3.50). Statements were still the most frequently expressed communicative act at this age, followed this time by a responsive act, that of answering a wh-question, and an imperative act, that of requesting. The authors did not record modality (communicative acts could be vocal, verbal or gestural), however they did note that gestures were integral to the interpretation of speech acts early on. For example, in instances of the infant directing the hearer's attention at 14 months, 85% of utterances were interpretable only by virtue of accompanying gesture, but this was down to 36% at 20 months, and down further to 5% at 32 months. This fits with findings that gesture use decreases with lexical development (Iverson & Goldin-Meadow, 2005; O'Neill, 2007).

In sum, the above review demonstrates that by 18 months, the typically developing infant is able to use communication for a variety of functional purposes in everyday interaction, including using the declarative motive (making statements, commenting, marking), the imperative motive (requesting, protesting), as well responsive acts (answering questions). They also use a range of modalities to express intention (from gesture to vocalisation and coordinated behaviours). What is less clear from the above is the amount of natural variation in the use of these skills and the next section goes on to consider what is and is not known about individual differences at this age.

3.1.2 Individual Differences in Early Communicative Intention

As set out in Chapter 1, section 3, Kidd et al. (2018) argue that since variation is a natural feature of all human experience, theories of communication must account for individual differences and empirical work should allow for three potential observations. Firstly, that individual differences in communicative behaviours may exist (**the existence imperative**). Secondly, that relationships may exist between communicative behaviours and environmental and experiential factors, such as input and socioeconomic status (**the environmental imperative**). Thirdly, that relationships may exist between theoretically separate sub-domains of communication, and any associations and dissociations may contribute to evidence of common or distinct underlying processes or mechanisms (**the architectural imperative**)

They also highlight that in comparison with infants’ lexical development, studies looking to establish individual differences in early socio-pragmatic skills are comparatively scant across all three imperatives (Bates et al., 1995; Kidd et al., 2018; O'Neill, 2014; O’Neill, 2007). This is evidenced by the fact that what we know about the typical development of communicative intention described above (section 3.1.1) comprises broadly work of two types, a) naturalistic studies to establish age and sequence of emergence of various speech acts where individual differences are not a primary focus (Bates et al., 1975; Carpenter, Nagell, et al., 1998; Snow et al., 1996), and b) experimental paradigms to establish universals in socio-pragmatic ability, which are designed to minimize variation and to elicit a speech act in isolation and unimodally (Behne et al., 2012; Boundy et al., 2019; Liszkowski et al., 2004a; Liszkowski et al., 2006). Both have significant value in contributing to our understanding of the typical developmental trajectory in early infancy, and subset (b) provide crucial evidence that infants often operate with specifically *communicative* intentions (and not just with informative intention, see Chapter 1, section 1.2.2). However, these abilities are often presented as universal and invariant which contradicts what we know about variation in most other cognitive processes such as memory and attention (Kane & Engle, 2002; Vogel & Awh, 2008).

It is important to note that there is an existing body of work that has used early individual differences in socio-pragmatic skill as a predictor variable for later formal language skill, usually vocabulary development (Brooks & Meltzoff, 2008; Colonnesi et al., 2010; Tomasello & Farrar, 1986), as well for other later social (Vaughan Van Hecke et al., 2007) and cognitive skills (Nichols, Fox & Mundy, 2005). However, for the current Chapter, we argue that early individual differences also have significant value in contributing to a synchronous picture of how dimensions of socio-pragmatic skills interrelate with each other *concurrently* whilst the infant is still relatively non-verbal and undertaking the transition from triadic to conventional communication.

3.1.2.1 Interrelations Between Socio-Pragmatic Skills and Formal Language.

Arguments for a pragmatics “domain” separable from other cognitive or linguistic components have been made in a variety of fields. Firstly, theoretical accounts of pragmatic language processing posit a code and inference model (Sperber & Wilson, 1986) wherein meaning is created by a dual but distinct processes of a) decoding words and grammar, and b) inferring speaker intentions, and assume separable ‘semantic’ and ‘pragmatic’ domains (Ariel, 2010). Secondly, evidence from atypical populations suggests that pragmatic communication can remain relatively unimpaired in the case of aphasia or Down’s Syndrome (where there are core language or articulatory problems; Goodwin, 2004), but is significantly affected in cases of autism where formal language is intact but socio-pragmatic reasoning is relatively impaired. Finally, there are several key studies that have looked to what infants are doing early on in development where precocious pragmatic skills allow them to communicate in the absence of conventional language and explored associations between these early pragmatic skills to look for evidence of underlying structures. These studies represent notable exceptions to the acknowledged dearth of work looking at individual differences in pragmatics and are detailed below.

In their longitudinal study of the development of speech acts, Snow et al. (1996) found that the earliest period in their sample, 14 months, was characterised by variation in terms of use of speech act types so much so that there was no individual speech act type that was used by more than a third of infants in the sample. At all time points (14, 20 and 32 months), there was a significant correlation between the total number of communicative attempts they made per minute overall (whether or not they could be assigned to a recognisable speech act) and the number of different speech act *types* they produced. The authors also noted that at 20 months large individual differences were particularly apparent in the extent to which children's speech was intelligible enough to assign any given utterance speech act. Since the study did not look for intercorrelations between the speech act types themselves (rather the variable was a measure of the infants' repertoire), there is little to conclude about the architectural imperative as it relates to speech act use. However, they did report correlations between the number of speech act types an infant used and a measure of word types and tokens across all time points. The association was strongest at 20 months (types (r = .58, p <.001), tokens (r = .65, p <.001), and weakest at 32 months (types (r = .40, p <.01), tokens (r = .36, p <.05) suggesting that pragmatic ability of this kind may provide an initial anchor for word learning but the two become less yoked over time. Overall, the authors conclude that their pragmatic and lexical measures, although related, are not redundant and demonstrate independence.

In their longitudinal study into the development of socio-cognitive skills of infants between 9 and 15 months, Carpenter et al. (1998) found significant correlations between the age of emergence of the ability to initiate joint attention using communicative gesture, the ability to follow joint attention (following others' gaze and pointing gestures) and the onset of referential language. They also reported significant, moderate correlation between the age of emergence of the infant's first declarative gesture with their first imperative gesture (r = .44, p <.05). They used this to argue for a connected socio-cognitive model (SCM) wherein all early socio-pragmatic skills are dimensions of a common underlying system specific to joint attention, but separate from general cognition (Tomasello, 1995). The SCM suggests that early skills are related as they are manifestations of the infants' understanding *about* others (intentions, knowledge states), and ability to experience *with* others (joint attention, shared goals) (Tomasello, 2010). The main methodological issue with this analysis, conceded by the authors, is the use of age of onset as the primary outcome variable. As these skills emerged in such rapid succession in their sample, the measure was not able to provide sufficient variation for correlational methods. Furthermore, Slaughter & McConnell (2003) found no significant correlations between joint attentional behaviours in their study of 8 – 14-month-olds). It is important to note however the correlation between age of emergence of the socio-pragmatic skills and referential language, again suggesting they are intertwined at the onset.

This work was advanced by Mundy et al, (2007) who instead of using age of emergence as outcome variable, looked for differences in performance on a series of structured tasks eliciting various communicative behaviours. The Early Social Communication Scales (ESCS; Mundy et al, 2003) is a battery of laboratory-based tasks that test for a number of behaviours demonstrating the ability to both initiate and respond to joint attention. The infant and experimenter are seated face to face and the experimenter presents opportunities for the infant to either initiate joint attention (IJA – i.e. to point and show toys with a declarative motive), to respond to joint attention (RJA – i.e. by following gaze or a point), to initiate behavioural requests (IBR – i.e. by asking for help winding up a toy), and to respond to behavioural requests (RBR – i.e. providing objects on request). Crucially, the ESCS allows for frequency measures within these tests and is therefore more suited to individual difference studies than age of onset.

At 9, 12, 15 and 18 months, the authors found that IJA and RJA showed no significant association within ages suggesting that the two subtypes of joint attention do not share common underlying mechanisms, although IBR and RBR was correlated significantly but weakly within ages (rs = .26, .26, .28, .22, $ps < .05$), thus reflecting the proposed separation of Bates et al. (1976) of the protodeclarative (here, IJA), and protoimperative (here, IBR).

Further patterns of divergence between the dimensions could also be evidenced in distinctive patterns of growth between 9 and 18 months (with RJA, IBR and RBR displaying linear growth patterns, and IJA showing a cubic growth pattern), and in the differential degrees to which they predicted language at 24 months (with early RJA predicting later language, but later IJA). The authors did not measure interrelations between the dimensions of joint attention and concurrent language skill.

Mundy et al. (2007) used these results to argue for a multiple process model (MPM) which suggests that different dimensions of joint attention skill are underpinned by both common and separate executive and cognitive processes and predicts the type of variation they were able to show. For them, these skills did not correlate because they are underpinned by different executive functions, degrees of attention regulation, self-other monitoring, and social motivation. For example, their measure of RJA (turning to follow a gaze or point) could be a reflexive and involuntary (Moore & Corkum, 1994) or imitative reaction (Mundy & Van Hecke, 2008) and therefore circumvent the types of processes involved in social engagement and motivation thought to be required for IJA (Bates, 1976). Similarly, the authors suggested that IBR/RBR did not correlate with other measures due to the attention required to make or respond to a request being more reflexive and less intentional than declarative communication.

However, one of the major limitations in moving away from naturalistic coding (such as (Snow et al., 1996), to the ESCS is that the latter captures mainly gestural or instrumental indicators of both IJA and RJA. It also limits responsive acts to the infant’s following the gaze of the experimenter or giving a toy on request and does not include any accompanying vocal or gestural indicators of responsiveness. The measure for RBR is action based/instrumental (i.e., ‘give me the toy’ and the infant responds by doing so), and not communicative, i.e., providing a vocal, verbal or gestural answer or acknowledgement), although they were able to show stability across ages in the use of gaze to initiate joint attention. Structured tasks can place constraints on the potential to measure variability by forcing a narrow set of outcomes, and in this way risk missing what infants actually *do* in interaction (as opposed to what they can do, see Tamis-LeMonda et al., 2017).

Standardised parental reporting is another method of capturing variation, but a vast majority of questionnaires measuring socio-pragmatic skills are not suitable for infants under three years of age. One exception is the Language Use Inventory and in validating the questionnaire, O'Neill (2007) found that scores on imperative (reaches, points) and declarative gestures (shows, gives, points) correlated significantly but fairly weakly ($r = .227$, $p < .01$). Norbury, Nash, Baird and Bishop (2004) suggested that in developing the Children's Communication Checklist-2, it became clear that pragmatic impairments affected quite heterogeneous subsets of pragmatic skills that appeared to have no underlying commonality so that aiming to profile children as being universally impaired in pragmatics was not feasible because "such discrete groups are not realistic" (Norbury, Nash, Baird & Bishop, 2004, p.362). This is a powerful argument in favour of exploring interrelations of dimensions of early socio-pragmatic behaviour synchronously.

It is worth noting that a systematic review looking at associations between pragmatic and formal language skills in older children (> 3 years) found moderate to high correlations in most studies (Matthews et al., 2018). However, many pragmatic tasks designed for older children, and which tap more sophisticated skills such as irony comprehension, narrative construction and perspective taking, often make heavy demands on lexical and grammatical (thus formal language) abilities in the attempt to illustrate pragmatic scenarios. In an attempt to address this issue, Wilson and Bishop (2021) designed a pragmatic task battery that minimised formal language demands for children agreed 7 to 13 years. Their correlational analysis showed weak correlations between the tasks themselves (which tapped variously implicature, pragmatic violations, and textual inference), suggesting they evidenced a task specific ‘family’ of skills rather than a coherent pragmatic domain. Confirmatory factor analysis showed separate loading of pragmatic and formal language skills but high association between these ‘domains’ (r = .79). They argue that even later in development, pragmatic and core aspects of language relate and could indicate interdependence in acquisition.

Overall, the evidence is mixed. For accounts looking at early ability to initiate and respond to joint attention, some report interrelations between dimensions of pragmatic skill (Carpenter et al., 1998), and some demonstrate divergent patterns of association for specific subtypes (Mundy et al., 2007). Furthermore, these are based on laboratory based structured tasks which may not yield the sufficient variation for correlational analysis. On the other hand, observational studies have either not focused on individual differences at all or have not provided correlational analysis between types of communicative intention (Snow et al., 1996). We propose to address these gaps by providing a naturalistic counterpart to the studies above, that explore the interrelations between communicative intention (and thus supposed dimensions of joint attention) and will inform our understanding of the architectural imperative as it pertains to early socio-pragmatic skill.

3.1.3 Research Questions

The present Chapter addresses several gaps and limitations identified in the literature above to provide a new look at early individual differences in communicative intention. Firstly, we aim to redress the generally acknowledged scarcity of individual differences studies in early socio-pragmatic skill (Kidd et al., 2018; O'Neill, 2014). More specifically, we set out to avoid the constraints on variability imposed by the use of structured laboratory-based tasks by focusing on the naturalistic observation of interaction between infants and caregivers in the home. The experimental method is an excellent way of demonstrating what infants can do, but not necessarily what they do (Tamis-LeMonda et al., 2017). For example, when infant walking is carefully elicited in a laboratory setting, at 14 months infants are able to follow a straight path with even pace. However, when measured in naturalistic settings, infant walking is circuitous and characterised by falls, pauses and variable pace and direction (Adolph et al., 2012). Furthermore, experimental methods minimise the noise, redundancy and competing stimuli that characterise everyday interactions, instead presenting stimuli in sequence and in isolation which is in direct contrast to the infant's everyday experience of communication (and therefore the natural context in which they acquire language) (Krogh-Jespersen & Woodward, 2016). We argue that converging evidence from several methods is necessary to gain a complete understanding of what infants are both able to do, and what they are motivated to do in everyday settings, aligning with calls for an integration of the experimental with correlational methods that allow for individual differences (Cronbach, 1957; Sternberg & Grigorenko, 2001; Underwood, 1975).

One final difference is that unlike Snow et al. (1996) we perform correlational analysis to look for interrelations *between* the types of communicative intentions produced by the infants (instead of collapsing this measure into an overall amount of speech act types), and we also examine *how* infants signal their intentions, exploring individual differences in modality. In this way, we aim to provide a complementary naturalistic account of variation in early socio-pragmatic skill to that of Carpenter et al. (1998) and Mundy et al. (2007), but which builds on the observational study of Snow et al (1996) by exploring interrelations between speech act types and addressing modality of expression.

In the work reported here, we explored infants' use of communicative intentions in interaction with their caregiver in a naturalistic setting to answer the following questions:

1. Are there notable individual differences in the frequency with which infants' express different communicative intentions across all modalities?
2. Does the frequency with which infants express a given intention (e.g., comments) tend to correlate with the frequency with which they express all other intentions (e.g., answers, imperative requests) across all modalities?
3. What modalities (gestural, vocal, combinations of the two) do infants use to signal intention and do some infants favour one modality as opposed to another (or is it the case that infants who gestures more also vocalise more)?
4. Are modalities (i.e., vocalisations, gestures or combinations) equally likely to be used to signal each type of communicative intention?
5. Across all modalities, does the frequency with which infants express a given intention co-vary with their concurrent formal language skill?

3.2 Methods

Chapter 2 sets out a full methodology for the collection and coding of a dataset of baseline measures that are used in this, and each subsequent chapter in this thesis. It is presented as a stand-alone chapter due to the complex nature of the naturalistic coding and to avoid repetition. However, in sum, we analysed video of interaction around unstructured play between 18-month-olds (N = 104) and their caregivers from across the South Yorkshire and East Midlands region. The principal outcome variable was a set of Communicative Intentions (CIs; comment, request, answer, acknowledgement, protest, greeting or game embedded turn) (Coggins & Carpenter, 1981; see Chapter 2, section 2.3.4 for reasoning behind the selection of the Communicative Intention Inventory as our coding taxonomy). As set out in Chapter 2, a decision was made to exclude protests (a behaviour that functions as a notice of disagreement or non-compliance to the suggestion of a caregiver) from further analysis due to poor inter-rater reliability. However, the two categories we initially added as per Ninio and Wheeler (1994), greetings and game embedded behaviour (i.e., providing the next verbal turn in a song), were also excluded from the final analysis presented below. These behaviours yielded low counts and tended to be heavily context dependent (saying hello or waving goodbye will only happen in a very narrow and specific scenario). Furthermore, game embedded behaviours were highly routinised and it was unclear how communicative this type of behaviour was. Modalities used to signal the intentions were also coded (including whether the intention was expressed vocally, gesturally, vocal-gesturally, or coordinated with a gaze to the caregiver). Vocalisations were further coded for whether they included a consonant-vowel combination or were a word (and whether they were a direct imitation) and gestures were coded for type (i.e., an index finger point, give, show). Measures of expressive and receptive vocabulary were also collected by parental report.

3.2.1 Approach to Analysis

To test for associations between the Communicative Intentions and formal language measures, non-parametric correlational methods were performed since most variables displayed positive skew and failed to meet the normality assumptions required for parametric methods (all communicative intentions except for comments deviated significantly from a normal distribution). Furthermore, Spearman’s rank correlation is thought to be less sensitive to outliers which in our observational sample cannot be discounted as measurement error.

3.3 Results

The results of analyses of the 18-month baseline dataset are presented in the following sections. Firstly, descriptive summaries and individual differences in frequency of expression of the various Communicative Intentions (CIs) are reported, and associations between them are examined. Secondly, we report individual differences in the *form* of expression of intentional communication and explore associations between these. We then look at correlations between these measures and formal language skill.

3.3.1 Individual Differences in Expression of Communicative Intentions

At 18 months, all infants in the group (N = 104) expressed at least one Communicative Intention (CI) from the 4 included categories during the 15 minute recording, with 99% (n = 103) producing at least one comment (the act of directing and sharing attention with another towards a referent, e.g. an infant shows or names a new toy in the direction of their caregiver so they look at and acknowledge it), 97% (n = 101) producing at least one request (the act of directing attention in order to obtain an object or action, e.g. an infant points to a mechanical toy car so that their caregiver will wind it up) , 89% (n = 93) at least one answer (the act of responding to questions with specific information, e.g. the infant produces the word “nana” in response to their caregiver’s question “ who is that?” as they gesture towards a photograph of the infant’s grandparents) and 94% (n = 98) at least one acknowledgement (an act that demonstrates recognition of an interlocutors’ utterance, signalling compliance or agreement, e.g. the infant nods their head when their caregiver says “can you pass me the block?”). On average, infants communicated intentionally five times per minute (mean frequency per minute = 5.17). The most commonly expressed CIs were as follows: comments (mean frequency per minute = 1.9), followed by answers (mean frequency per minute = 0.9), requests (mean frequency per minute = 0.7), and acknowledgements (mean frequency per minute = 0.6). Descriptive statistics for the CIs (across all modalities, whether vocal, gestural, vocal-gestural or verbal) are presented below.).

Table 1

Descriptive Statistics for all Communicative Intentions expressed per minute (N = 104)

	Minimum	Maximum	Mean	SD	Median
Overall intentional acts	0.39	12.75	5.17	2.53	4.87
Comments	0	5.35	1.94	1.12	1.77
Requests	0	5.19	0.75	0.84	0.53
Answers	0	3.07	0.93	0.72	0.81
Acknowledgements	0	3.24	0.56	0.54	0.45

3.3.1.1 Effects of Condition and Gender. As it was possible that the intervention condition that infants in this sample had been allocated to at 11 months (see Chapter 2, section 2.1.1) could have an effect on the frequencies at which they expressed the various Communicative Intentions (CIs), a Mann-Whitney U test was conducted to test for significant differences between the two intervention condition groups. A non-parametric test of independent samples was chosen due to the non-normal distributions of the CI data (all displayed significant deviation from the normal distribution in a Shapiro-Wilks test (p = < 0.5). Distributions of the frequencies for the two intervention condition groups were similar, as assessed by visual inspection, and so a comparison of medians was deemed appropriate. Overall, there were no significant differences between the frequency of CI expression per minute and intervention condition (comments, U = 1206, p = .368; requests, U = 1345, p = .995; answers, U = 1411, p = .662; acknowledgments, U = 1206, p = .370). Next, the same test was performed to ascertain any differences in frequencies of CI expression and gender. However, unlike condition, there were some dissimilar distributions across the CIs for gender, as assessed by visual inspection, and so groups were compared by rank mean. There was no significant difference between gender groups and the following CIs (comments, $U = 1115$, $p = .135$; requests, $U = 1220$, $p = .419$). However, there were significant differences between gender and the expression of the responsive speech acts answers ($U = 878$, $p = .002$) and acknowledgements ($U = 991$, $p = .021$) with female infants providing answers and acknowledgements more than males. Since these CIs are measures of the dyad, it is difficult to unpick whether this is a difference inherent to the infant, or more a function of how often the caregiver is addressing the infant. This is discussed further in section 3.4.

3.3.1.2 Correlations Between Communicative Intentions. Table 2 presents correlations for the frequency of expression of the CIs per minute.

Table 2

Correlation Coefficients (Spearman's rho) for Communicative Intentions expressed per minute (N = 104)

	Comments	Requests	Answers	Acknowledge-ments
Comments				
Requests	.298**			
Answers	.342**	.232*		
Acknowledgements	.350**	.182	.542**	

*p<0.05

**p<0.01

3.3.2 Individual Differences in Modalities

In terms of how the infants in our sample signalled the intentions above, all infants vocalized intentionally, and most produced at least one solo intentional gesture (91%, *n* = 95). The majority of infants produced at least one intentional vocal-gesture combination (92%, *n* = 96), and almost all infants gazed at least once to their caregiver during, or within one second, of their producing a vocalisation, gesture or vocal-gesture combination (98%, *n* = 102). Vocalisations were gaze coordinated at least once by 97% of the infants (*n* = 102), vocal-gesture combinations were gaze coordinated by 85% of the infants (*n* = 89), but fewer solo gestures were gaze coordinated one or more times (63%, *n* = 66). In terms of attribution of intention to the various modalities, 98% of solo gestures and 96% of vocal-gesture combinations were coded as intentional, whereas only over half of solo vocalisations were coded as intentional. Infants vocalized intentionally at an average rate of 3.56 times per minute, followed by vocal-gesture combinations at an average of 1.09 times per minute. Gestures were much more much less likely to occur as solo acts to signal intention, at an average of 0.53 per minute. As can be seen in Table 3, there were individual differences in the use of each modality to signal intention.

Table 3

Descriptive Statistics for Infant Intentional Acts (N=104) per minute

	Minimum	Maximum	Mean	SD	Median
Intentional solo vocalisations	0.32	10.40	3.56	1.90	3.27
Intentional solo gestures	0	3.20	0.53	0.52	0.37
Intentional vocal-gesture combinations	0	5.25	1.09	0.98	0.79
Gaze coordinated intentional acts	0	5.44	1.37	1.06	1.17

3.3.2.1 Effects of Condition and Gender. It was also possible that the intervention condition that infants in this sample had been allocated to at 11 months (see Chapter 2, section 2.1.1) could have an effect on the forms used to express intentions at 18 months. To test for effects of condition, a Mann-Whitney U test was performed (as above, a non-parametric test of independent samples was chosen due to the non-normal distributions of the data as indicated by a Shapiro Wilks test). Overall, there were no significant differences between modality produced per minute and intervention condition (intentional vocalisations, $U = 1245$, $p = .519$; intentional gestures, $U = 1418$, $p = .627$; intentional vocal-gesture combinations, $U = 1209$, $p = .380$). Those who had taken part in the intervention tended to gaze more (*Mdn* = 1.44) than those in the control condition (*Mdn* = 1.06) during intentional communication, but this difference was only approaching significance ($U = 1052$, $p = .057$).

For most of the modalities and formal properties there were significant differences between genders with females producing significantly more intentional vocalisations ($U = 1032$, $p = .042$), intentional gestures ($U = 918$, $p = .005$) and intentional vocal-gesture combinations per minute (*U* = 952, *p* = .011). Female infants also coordinated their communicative acts with gaze to the caregiver significantly more than male infants in this sample (*U* = 891, *p* = .003. Associations between the modalities and measures of socioeconomic status are explored in Chapter 5.

3.3.2.2 Correlations Between Modalities. Table 4 presents correlations between modalities used per minute.

Table 4

Correlation Coefficients (Spearman's rho) for Modality of Communicative Intentions expressed per minute

	Intentional solo vocalisations	Intentional solo gestures	Intentional vocal-gesture combinations	Gaze coordinated intentional acts
Intentional solo vocalisations				
Intentional solo gestures	.103			
Intentional vocal-gesture combinations	.410**	.642**		
Gaze coordinated intentional acts	.572**	.334**	.568**	

*p<0.05

**p<0.01

3.3.2.3 Relations Between Communicative Intentions and Modality. Table 5 presents the frequencies and proportions of each CI as expressed as a vocalisations, gesture, and gesture-vocal combination. Generally speaking, most communicative acts were expressed purely by vocalisation except for requests which were more likely than other intentions to be expressed with gestures as well as vocalisation.

Table 5

Proportion of each Communication Intention (CI) expressed as Vocalisation, Gesture or Vocal-gesture Combination (N=104)

	Proportion expressed as solo vocalisation (Raw frequency)	Proportion expressed as solo gesture (Raw frequency)	Proportion expressed as vocal-gesture combination (Raw frequency)
Comments	65.8% (1747)	11.6% (309)	22.6% (600)
Requests	46.6% (479)	13.8% (140)	39.7% (408)
Answers	69.8% (906)	11.2% (145)	19.0% (247)
Acknowledgements	86.5% (1368)	5.6% (89)	7.9% (125)
Unintentional	98.8% (3213)	1.0% (32)	0.2% (7)

Table 6 presents the rates at which each CI occurred with or without gaze to the caregiver. Generally speaking, most communicative acts were expressed without gaze to the caregiver, but rates of gaze coordination were higher for intentional than apparently unintentional acts.

Table 6

Proportion of each Communication Intention (CI) coordinated with a gaze to caregiver

	Proportion coordinated with a gaze to caregiver (Raw frequency)	Proportion without gaze coordination (Raw frequency)
Comments	25.7% (682)	74.3% (1974)
Requests	30.5% (313)	69.5% (714)
Answers	28.6% (371)	71.4% (927)
Acknowledgements	23.3% (369)	76.7% (1213)
Unintentional	12.5% (405)	87.5% (2847)

3.3.3 Associations Between Communicative Intentions and Formal language

Table 7 presents a descriptive summary of a measure of parental export of expressive and receptive vocabulary as measured by the Lincoln UK adaptation of the Bates McArthur Communicative Development Inventory (Infant Form; Meints, 2000) LCDI. Table 8 displays correlations between expression of the CIs, word tokens and types manually coded from the naturalistic video, and parental report of the LCDI. As can be seen, the naturalistic measure of the number of word tokens each child produced is highly correlated with the number of word types they produced and their caregiver's report of expressive vocabulary. The relationships between these variables are presented as scatterplots in Appendix C.

It is important to note that a number of parental reports are missing from the final dataset (n = 15). However, in accordance with guidance from Peugh and Enders (2004), we considered the data to be missing completely at random (MCAR) because the factors that led to its absence are entirely unrelated to infant performance and instead related to random factors such as postal issues, or parent completing an insufficient proportion of the entire report. We therefore took the decision to run the correlation using pairwise deletion in order to minimise data loss.

Table 7

Descriptive Statistics for Parental Report of Expressive and Receptive Vocabulary at 18 months (LCDI)

	N	Minimum	Maximum	Mean	SD	Median
Expressive vocabulary (LCDI)	89	0	325	81.91	75.78	52
Receptive vocabulary (LCDI)	89	19	399	231.22	87.22	237

Table 8

Correlation Coefficients (Spearman's rho) for Frequency of Communicative Intentions per minute & Formal Language (N = 104)

	1	2	3	4	5	6	7	8
1. Comments pm								
2. Requests pm	.298**							
3. Answers pm	.342**	.232*						
4. Acknowledges pm	.350**	.182	.542**					
5. Words (tokens) pm	.622**	.415**	.674**	.475**				
6. Words (types) pm	.537**	.315**	.598**	.330**	.887**			
7. Expressive vocabulary (LCDI)	.347**	.362**	.509**	.196	.708**	.786**		
8. Receptive vocabulary (LCDI)	.261*	.181	.407**	.233*	.436**	.461**	.644**	

*p<0.05

**p<0.01

3.4 Discussion

The present Chapter aimed to provide a naturalistic picture of how frequently infants use various communicative intentions in everyday interactions and to explore the extent to which these intentions may interrelate and correlate with concurrent use of formal language. In doing so, it attempted to provide a naturalistic counterpart to the early associations and dissociations found by Mundy et al. (2007) and Carpenter et al (1998) in laboratory based structured tasks, and to contribute to our understanding of the underlying architectural interplay between early socio-pragmatics skills and formal language. Below, we discuss findings for each research question in turn.

3.4.1 Are There Notable Individual Differences in the Frequency With Which Infants' Express Different Communicative Intentions?

Overall, our sample of first-born infants showed similar group-based results to the naturalistic findings of Snow et al. (1996). On average, 18-month-old infants in our study expressed five communicative intentions per minute (compared with an average of four per minute at 14 months, and eight per minute at 20 months as found by Snow et al., although the authors reported that 20% of these acts were uninterpretable at 20 months). Just as striking were similarities in standard deviations around the means in our sample at 18 months (*SD* = 2.53), and in Snow's (*SD* = 2.60 at 14 months, and *SD* = 2.80 at 20 months). Furthermore, the most commonly expressed CI in our sample was in the declarative motive (comment), followed by a responsive act (answers), then by the imperative (requests) and finally acknowledgements. This almost mirrors the sequence found by Snow et al. at 20 months with the most frequent being declarative statements, followed by answering a wh-question, and then by requesting. Although it is important to bear in mind that their coding scheme the INCA-A is much more fine-grained and so our categories may not map precisely onto each other, this is a fairly striking parallel given the studies are a generation apart and undertaken in different parts of the world (UK, US), and at least in the current study, across a range of socioeconomic backgrounds (see Chapter 4 for a breakdown of socioeconomic factors in our sample). It would be interesting to see if this is replicated in future studies to examine the potential that this is a universal developmental sequence for speech acts that is somewhat impervious to geography and socioeconomic factors (but not necessarily across cultures however as the UK and US are both Western, educated, industrialized, rich and democratic (WEIRD; Henrich et al., 2010). This may indicate potential to establish norms comparable to formal measures such as Mean Length of Utterance or the MacArthur-Bates Communicative Development Inventories.

3.4.2 Does the frequency with which infants express a given intention (e.g., comments) tend to correlate with the frequency with which they express all other intentions (e.g., answers, imperative requests)?

Firstly, in checking for effects of gender and condition, we found that the frequency with which infants produced answers and acknowledgements differed by gender, with higher frequencies for female infants. Snow et al. (1996) did not include gender differences in their analyses, and Mundy et al. (2007) showed an advantage for girls in initiating joint attention at 9 months and a slight advantage for girls in requesting at 12 and 15 months, but nothing to indicate that female infants are generally more responsive than males. However, this aligns with the previous finding that female infants in our sample are more likely to look to their caregiver during interaction which suggests they may be more primed to respond to communicative bids. Future research should explore whether female infants are given more opportunity to respond.

Overall, answers and acknowledgements were the most highly correlated communicative intentions. The frequency of use of other CIs in our sample (across all modalities) generally showed significant positive but weak intercorrelations. It is worth comparing this finding with those of Mundy et al. (2007), who observed a disassociation between their measures of 1) Initiating Joint Attention (IJA - pointing and showing in the declarative motive), 2) Responding to Joint Attention (RJA - following points), and 3) Initiating/Responding to Behavioural Requests (IBR - requesting an object or action, IBR - or providing one on request). Instead, our initiative declarative measure (comments), initiative imperative measure (requests) and responsive measures showed significant but weak correlation, indicating that at 18 months in our sample the more frequently one type of communicative intention is expressed, the more frequently the others are too, regardless of their initiative or responsive to joint attention subtypes, and in this way is more comparable with the results of Carpenter et al (1998). However, it is important to note that these are vastly different measures. Mundy et al. (2007) used the Early Social Communication Scales (ESCS; Mundy et al, 2003) to measure differences in their sample, but it is a measure of competence administered by laboratory based structured task and therefore not a measure of what infants do naturalistically. Some of the measures do require the expression of a communicative intention (i.e., showing and pointing to initiate joint attention) but others demand only an instrumental response and not a communicative one, for example responding to joint attention (RJA) requires only that the infant to follow the point of the experimenter. Contrast this with our responsive measures (answers and acknowledgements) which require a vocal or gestural response (as well as the requisite responsive action).

Although the results in the current study side more with a common social-cognitive model of Carpenter et al (1998) wherein initiating and responding to joint attention intercorrelate due to common underlying construct it is important to once again acknowledge the differences in measures. Our measure is one of motivation to express intention, rather than underlying competence and as the majority of intentions co-vary, it is not impossible that we have captured a general motivation factor (comparable to the concept of a general ‘g’ factor explaining task differences in terms of general cognitive ability (Jensen, 1999), or that in Bates' words "good things go together" (Bates, 1988, p. 13). Indeed, the current study did not control for possible cognitive covariates as did Mundy et al. (2007), however we felt this was justified in that naturalistic observation does not impose any task demands that would require baseline cognitive skills beyond general processing demand in keeping up with their everyday interactions. Even if the measure is one of communicative motivation, this is not without import, for example, it has been argued that individual differences in motivation to communicate contribute to behaviour and personality in adulthood (Langston, 1994). Furthermore, if the development of communicative intention is the product of social interactions and gradually constructed by the dyad (Carpendale & Lewis, 2004; Vygotsky, 1986), the general motivation of the infant to produce communicative bids will have positive effects on the caregiver (Vallotton, 2009), compounding caregiver responsiveness and encouraging mutual reciprocity, and in this way the infant will have a hand in their own development (Scarr, 1992).

Unfortunately, the scope of the thesis did not permit analysis of the caregiver's naturalistic input so it difficult to draw any conclusions about the how much the infant is being influenced by the caregiver (i.e., an infant can only be responsive if there is input to respond to). However overall, as the correlations are weak to moderate, we conclude that the communicative intentions may form a set of related but multi-faceted skills that still demonstrate a degree of independence. In this way, they may be described as a "family of skills rather than a domain" (Wilson & Bishop, 2020, p. 1) and we are satisfied that the measures can be taken forward without risk of redundancy to explore associations with performance on structured tasks (in Chapter 4) and environmental measures (in Chapter 5).

3.4.3 What modalities (gestural, vocal, combinations of the two) do infants use to signal intention and do some infants favour one modality as opposed to another (or is it the case that infants who gestures more also vocalise more)?

In our sample, communicative intention was predominantly expressed in the vocal modality, followed by the vocal-gestural, followed by the gestural. However, there were individual differences in modalities used to express intention (with solo vocalisations ranging from 0.32 – 10.40 per minute; solo gestures ranging from 0 – 3.20 per minute, vocal-gesture combinations ranging from 0 – 5.25 per minute, and the coordination of a gaze to caregiver with an intentional act ranging from 0 – 5.44). Furthermore, for most of the modalities, there were differences between genders with females producing significantly more intentional vocalisations, intentional gestures and intentional vocal-gesture combinations per minute. Female infants also coordinated their communicative acts with gaze to the caregiver significantly more than male infants in this sample. This is perhaps not surprising, female infants have been shown to acquire vocabulary earlier than males, their lexicon is often larger (Bornstein & Haynes, 1998). They are more likely to orient to the direction of others' gaze than males and at 12 and 14 months make more eye contact with caregivers than boys (Lutchmaya & Baron-Cohen, 2002) with recent studies showing an inverse correlation with this latter skill and exposure to neonatal testosterone (Lutchmaya et al., 2002). However, it is difficult to unpick the direction of influence between caregiver and infant that may underlie these differences. Caregivers communicate more frequently to female infants (Leaper et al., 1998) and are more likely to respond negatively to the communicative bids of male infants than to those of female infants.

The modalities showed significant moderate correlations between the frequency of solo vocalisation and vocal-gestures, and between solo gesture and vocal-gestures per minute. However, there was a weak and non-significant correlation between the frequency of solo vocalisations and solo gestures, suggesting a divergence between those who are able to coordinate behaviours but have a solo modality preference for vocalisations, and those who coordinate behaviours and have a solo modality preference for gestures. As vocalisations included idiosyncrasies, proto-, and conventional words, it is possible that dissociation is analogous with existing findings that as the infant gets to grips with conventional language, the reliance on gesture decreases (Iverson & Goldin-Meadow, 2005; O'Neill, 2007).

3.4.4 Are modalities (i.e., vocalisations, gestures or combinations) equally likely to be used to signal each type of communicative intention?

The tendency to express communicative intention vocally, gesturally or by combining a vocalisation and gesture also differed according to intention type. Unintentional acts were overwhelmingly solo vocalisations. Requests were the most common Communicative Intention expressed using a vocal-gesture combination (40%), followed by comments (23%), answers (19%) and acknowledgements (8%). This aligns with previous findings that infants tend to combine vocalisations and gestures to perform requests in the imperative motive (Messinger & Fogel, 1998), presumably because their desire to obtain something motivates the infant to make their communicative act as salient and impactful as possible. Across the cohort, the tendency to coordinate gaze to the caregiver differed according to communicative intention type. Eighty seven percent of acts considered unintentional (and not assigned a Communicative Intention) were not coordinated with a gaze to caregiver indicating that gaze is a reliable indicator of intention in naturalistic schemes (Bates et al., 1975; Donnellan et al., 2020; Franco & Butterworth, 1996a).

3.4.5 Across all modalities, does the frequency with which infants express a given intention co-vary with their concurrent formal language skill?

Firstly, our two measures of formal language skill, one a parental report of expressive vocabulary (LDCI) and the other a naturalistic count of word types and tokens produced during the video were significantly and strongly correlated. In our sample, infants whose parents reported a larger expressive vocabulary were also observed to produce more words in naturalistic observation lending convergent validity to the parental report measure which we will use throughout the remainder of the thesis. This is particularly important given the findings that parental report can often be problematic for groups from differing socioeconomic backgrounds which we expand on in Chapter 5 (see also Pine et al., 1996).

All communicative intentions showed significant weak to moderate correlation with concurrent formal language skill as measured by the LCDI, except for acknowledgements. The disassociation between acknowledgements and concurrent vocabulary can be explained by the tendency for acknowledgements to be a conventional gesture (nod or shake of the head), or if verbal, “yeah” or an idiosyncratic vocalisation, both of which were not coded as conventional language in our scheme. The fact that the other CIs correlate with concurrent formal language indicates that the expression of communicative intentions in early infancy is closely intertwined with formal language skill as predicted by usage-based accounts wherein pragmatics is central to the acquisition of language and to word learning, at least early on (and they become less yoked over time, as is the case for joint attention and vocabulary, Carpenter, Nagell, et al., 1998; Morales et al., 2000).

In conclusion, our findings demonstrate a number of relationships that suggest that spontaneous intentional communication and vocabulary development are closely intertwined, at least early on in infancy. Firstly, the frequency of expression of the different CIs also intercorrelated significantly (so that a tendency to comment more is associated with a tendency to request more and so on). Secondly, the amount of words spoken by infants in the naturalistic video footage (tokens and types) correlated significantly with their spontaneous expression of most of the Communicative Intentions types (CIs), as well as with the parental reports of both expressive and receptive vocabulary. This suggests a) a close developmental interplay between the formal and functional aspects of communication, and b) that the parental report of vocabulary (the LCDI) is a valid measurement of the infants' lexical skills. Associations in the naturalistic data having been established, Chapter 4 goes on to explore this naturalistic data in conjunction with infant performance on a series of structured tasks to test for correlations with a wider range of pragmatic skills beyond spontaneous expression of intention in interaction.

4. How Does Performance on Socio-Pragmatic Structured Tasks Relate to Naturalistic Observation of Communicative Intention?

Abstract

Chapter 3 explored the naturalistic expression of various communicative intentions (comments, requests, answers, acknowledgements) in a sample of 18-month-olds (*N* = 104) and revealed significant individual differences in the frequency of expression of all the communicative intention types during an unstructured play session with their caregiver. The present chapter set out build on this in two ways. Firstly, we aimed to test the feasibility of administering four structured tasks in a home setting that would elicit pragmatic behaviours without having to wait for them to occur naturally. Secondly, for those tasks that could feasibly be administered, we set out to determine whether individual differences in the infants' elicited performance correlated with individual differences in their naturalistic interaction. The first three tasks aimed to elicit the following theoretically pragmatic behaviours in order to resolve referential ambiguity; using (1) Mutual Exclusivity/disambiguation principles, (2) the direction of interlocutor gaze and (3) appeal to common ground. A final task (4) elicited behavioural requests and communicative repair behaviour from infants during a communicative frustration/breakdown episode. Two of these four tasks were excluded from analysis due to being developmentally inappropriate (Task 1, Mutual Exclusivity/Disambiguation), or having insufficient controls (Task 3, Using Common Ground). A small subset of the sample were able to participate in the remaining tasks (Task 2, Following Gaze for Reference Resolution, *n* = 38 and Task 4, Requesting and Repair, *n* = 48). Correlational analysis on the participating subsets showed a weak, negative, but significant association between infant performance on Task 2 (requiring infants to follow the gaze of an experimenter to map a novel label to a novel object), and the number of requests

the infants produced in a naturalistic play setting. We also saw significant positive correlation between the infants' performance on Task 4 (which required the infant to initiate a behavioural request to an ignorant partner and repair miscommunication), and the frequency of comments the infants produced naturalistically. There was a weak, non-significant correlation between task performance, and parental report measures of expressive and receptive vocabulary and imperative and declarative gesture use. Overall, the pragmatic tasks associated sporadically with the naturalistic expression of communicative intentions which may reflect the small sample size to some degree but also suggests that the two are not universally related. Rather the tasks may reflect dimensions of pragmatic ability that contribute differentially to the expression of specific communication intention types in interaction.

4.1 Introduction

Garner et al. (1956, p. 150) coined the term "converging operations" to argue that any psychological phenomenon is unlikely to be sufficiently captured by any one methodology, and many since have echoed the call to integrate methodologies to provide convergent validity (Bates, 1988; Sternberg & Grigorenko, 2001; Underwood, 1975). From the point of view of studying individual differences, one of the principal drawbacks of using experimental paradigms to measure communicative development (as opposed to the naturalistic observations reported in the previous chapter) is that they minimise individual differences *by design* (Kidd et al., 2018). The experimental focus on the comparison between conditions reduces individual differences to error variance and strips environments of naturally occurring stimuli so as to dampen idiosyncratic reactions (Cronbach, 1957). Bronfenbrenner sums up the downsides of applying the experimental method to communicative development since it measures "the strange behavior of children in strange situations with strange adults for the briefest possible periods of time" (Bronfenbrenner, 1977, p. 513). However, correlational and factor analysis of naturalistic data is also not without disadvantages. For example, it could be argued that requiring an infant and caregiver to spend *uninterrupted* time in structured play is somewhat of an artificial context given the scarcity with which this happens in everyday life (Ambridge & Rowland, 2013). Furthermore, what naturalistic approaches gain in ecological validity, they lose by not being able to rigorously control for possible confounding variables, and they are less powerful in showing what infants *can* do as opposed to what they frequently *do* do.

An alternative method to capturing individual differences outside of naturalistic observation is the standardised task. Standardised tasks are invaluable in allowing for meaningful comparison across studies and populations, but they have been also criticised for providing a mere snapshot into a child's communicative repertoire (Leonard et al., 1978), and thought to be particularly problematic for children younger than three years (Fenson et al., 1993). The only standardised tasks suitable for capturing early pragmatic behaviours in infants younger than 18 months is the Early Social Communication Scales (ESCS; Mundy et al., 2003). In a 20-minute laboratory-administered assessment, the ESCS captures a range of joint attentional behaviours, including infant ability to initiate joint attention (IJA), respond to joint attention (RJA), initiate behavioural requests (IBR), and to respond to behavioural requests (RBR). The IJA tasks measure infant gaze alternation between the tester/caregiver and a wind-up toy, and their pointing to and showing of the toy simply to share attention towards it. The RJA task measures infants' following the gaze of a tester towards posters that had been put up on the walls around the testing room. The IBR tasks elicit infant reaching, pointing and giving gestures (and measures any accompanying eye contact) that function as a request to obtain toys that have been moved out of reach or the reactivation of mechanical toys that have stopped moving. Finally, the RBR task measures infant responses to tester requesting of objects.

These tasks were found to be particularly effective in measuring individual differences between 9 and 18 months. For example, Mundy and colleagues (2007) observed that performance on the IJA (e.g., pointing and showing) and RJA tasks (e.g., following a point) did not correlate within or between ages, but infant performance on the IBR/RBR tasks did (Mundy et al., 2007). The authors used these findings to argue for a model of joint attention wherein various dimensions of joint attention were underpinned by differing executive, cognitive and social processes, and not as highly connected as assumed under the social-cognitive model of joint attention (Tomasello, 1995).

However, despite its efficacy in capturing individual differences, there were several barriers to using the ESCS for the current work. Firstly, the tasks require a significant amount of time and an elaborate set up in a laboratory situation (including pinning up posters, very specific positioning of caregiver, infant and tester and a clear testing room) which was not appropriate for collecting data from infants in a home environment (see Chapter 2 for detailed data collection procedure for the work set out in this thesis). We felt that asking the participants of our study to come into the Laboratory for the ESCS assessment (or even a subset of participants) might have been discouraging for families taking part in this largely home based project, particularly those from lower socioeconomic backgrounds who are more likely to face challenges with transport, income and time (Spoth & Redmond, 2000). Secondly, the tasks that make up the ESCS also assess skills in isolation from each other which is not necessarily reflective of how the child would use these skills in reality, for example IJA task counts only their efforts in the gestural modality which may miss abilities in other modalities (see recent calls for studying multi-modal communication; Esteve-Gibert et al., 2017). Finally, many of the individual tasks within the ESCS, such as that for RJA (e.g. gaze following) do not require the infant to use joint attentional behaviours to solve a problem or to overcome a frustration, the infant is invited to simply look where the tester is looking (a potentially reflexive action; Moore & Corkum, 1994), and not to do so in order to resolve some referential ambiguity (Baldwin, 1991) or repair a communicative breakdown (Golinkoff, 1993). Experimental paradigms elicit this sort of 'means to an end' behaviour much more frequently than standardised tasks such as the ESCS but are not used for the purposes of highlighting individual differences.

In light of this, we devised four tasks which represented adaptations of 'means to an end' experimental paradigms, but which allowed for individual differences in performance. Three of these tasks were adaptations of reference resolution paradigms. The first and second required the infant to select the referent of a novel word using (1) disambiguation/mutual exclusivity, and (2) by following interlocutor gaze. The third asked the infant to appeal to common ground to select the referent of an ambiguous point from the experimenter based on what they had previously experienced together (and therefore what they reasoned about the experimenter's epistemic state). For the fourth, a communicative frustration episode was set up whereby the infant had to initiate a behavioural request, similar to Task H in the ESCS whereby the experimenter presents the infant with a closed plastic jar containing a toy and the infant has to initiate a behavioural request to get the toy. However, in our task, the infant must also engage in repair mechanisms when their interlocutor (in our case, the infant's own caregiver) pretended they did not understand the infants' intention. These measures were selected according to a) how likely they were to expose individual differences in performance in a typically developing cohort and b) how representative they were of the variety of pragmatic behaviours evident at 18 months.

A first goal was simply to see if these tasks would work in home environment. A second goal, in exploring associations between task performance and our naturalistic measure of communicative intentions, was to shed further light on potential convergence/divergence between proposed dimensions of pragmatic skills, and thus contribute to our understanding of the separability of pragmatic behaviours and formal language (i.e the architectural imperative, see Chapter 3, section 3.1.2; Kidd et al., 2018). The next section goes on to outline in further detail the rationale behind the adaptation of the experimental paradigms in turn), and then we set out our research questions and make some predictions according to the extant literature on the nature of pragmatics in ontogeny.

4.1.1. Task 1 – Using Mutual Exclusivity for Reference Resolution

Broadly speaking, mutual exclusivity is thought to be the guiding principle behind success on disambiguation tasks which ask infants to identify the referent of a novel label (e.g., 'dax') from two items, one a familiar object (e.g., a spoon), and the other a novel item. Success is taken to mean the infant selecting the novel item as the 'dax' on the basis of either a) a simple learning general principle, b) a specifically lexical principle which dictates that one object can only have one name (Markman, 1991; Markman et al., 2003), or c) a richer socio-pragmatic principle of contrast by which infants take their interlocutors to be operating intentionally and contrastively (i.e. 'if my interlocutor intended to say the spoon, she would have said the spoon, she didn't, she said 'dax', so she must mean the novel item instead' (Clark, 1990). Infants as young as 17 months reliably succeed in matching novel label with novel item, thus avoiding lexical overlap (Halberda, 2003), although there is evidence that infants as young as 10 months also disambiguate successfully according to this principle (Mather & Plunkett, 2010).

Can this expectation that one object will have one label (and not multiple) really be said to involve socio-pragmatic mechanisms relating to understanding others as intentional (Bloom, 2000; Clark, 1990, 2009; Diesendruck, 2005)? On the one hand, the ability to use the mutual exclusivity principle correlates positively with expressive and receptive vocabulary (Graham et al., 1998), suggesting that the principle does indeed contribute to word learning. Furthermore, the ability to use mutual exclusivity is unimpaired in ASD with socio-pragmatic but not structural language difficulties (de Marchena et al., 2011; Preissler & Carey, 2005) which led the authors to argue that it was a principle specific to the lexical domain. However, there is also evidence that its use can be influenced by potentially pragmatic factors. Disambiguation ability is strengthened when it is accompanied by extralinguistic cues (speaker gaze and gesture; Graham et al., 2010), is weakened by an interlocutor who has shown themselves to be unreliable (Diesendruck, 2005) and influenced by factors in the child's language environment. For example, monolingual infants apply the principle more reliably than bilingual peers (Byers-Heinlein & Werker, 2009; Houston-Price et al., 2010), presumably because the language environment of the bilingual infant permits 2:1 mappings between label and referent (i.e. one referent can have two labels in different languages). However, both monolingual and bilingual infants use mutual exclusivity with a speaker who is the same race as them, but not with a speaker with an unfamiliar race (Weatherhead et al., 2021). However, although its use can be influenced, it has been shown to top the hierarchy of disambiguation strategies, for example, it has been shown to trump following the gaze of your conversational partner when infants are confronted with these two competing cues. For example, Graham et al. (2010) found that infants preferred to use mutual exclusivity to guide their interpretations rather than where their interlocutor is looking.

Overall, mutual exclusivity appears to be an important method that infants use to constrain their hypotheses when mapping novel labels to objects around them. However, little is known about whether there are individual differences in the use of this heuristic outside of the important work on bilingualism detailed above that suggests prior experience with language has an effect on use. To our knowledge there is no work to date which seeks to establish links with other pragmatic abilities, and we argue that this has potential to contribute to the debate between lexical constraints and socio-pragmatic accounts of word learning.

4.1.2 Task 2 – Following Gaze for Reference Resolution

Before the age of 10 months, infants simply map the words they hear from others onto to objects that they themselves are looking at rather than on what their interlocutor's gaze is focused on (Pruden et al., 2006). At around 12 months, infants begin to reliably follow their interlocutor's direction of gaze (Butterworth & Grover, 1988), start to connect the person looking to the object being looked at (Woodward, 2005), use gaze to predict the behaviour of others (Phillips et al., 2002), but still do not use gaze following as a cue in object-label mapping situations (Brand, 2000). However, by 13 months infants start to seek clarification from speakers' eyes in referentially ambiguous contexts where there are two or more potential referents in an array (Vaish et al., 2011) and by 18 months, they reliably use gaze to identify the correct referents of others' attention and furthermore to use it for word learning (Baldwin, 1991, 1993; Baldwin et al., 1996; Moore et al., 1999). Thus, by 18 months, gaze has acquired significant referential weight in interactions and is a reliable strategy for infants in the difficult process of mapping the correct form to the correct object in the world around them (Baron-Cohen et al., 1997; Quine, 1960). In Baldwin's classic 1991 study, 18-month-olds were shown to use interlocutor direction of gaze to map a novel label to a novel referent in both a 'following-in' condition in which the item was labelled when both the infant and the experimenter were looking at it, and in a 'discrepant labelling' condition when the both the experimenter and the infant were looking at their own toys. In this second condition, infants were able to use the gaze of their interlocutor to avoid egocentrically selecting the item that they themselves were looking at, demonstrating that they had monitored the gaze of their interlocutor. Indeed, individual differences in early gaze following predict later formal language skill, i.e., expressive vocabulary (Brooks & Meltzoff, 2005, 2008; Tenenbaum et al., 2015; Tomasello & Farrar, 1986) and so it appears to be clearly implicated in word learning.

However, there is debate as to whether gaze following could be characterised as a pragmatic skill. Leaner interpretations of the ability would suggest that it is a manifestation of the infant's expectation of an interesting sight after an adult head turn, rather than an expectation to see something that the adult intended them to see (Moore & Corkum, 1994). However, a richer interpretation (i.e., one that would assume the infant is operating with a suite of sophisticated social-cognitive skills outlined in Chapter 1, section 1.2.1, and Chapter 3, section 3.1.1.2) would suggest that it involves not only motoric co-ordination and an integration of visual and auditory cues, but crucially the understanding of others as attentional and intentional beings (Tomasello, 2010). In line with these accounts, even infants at 12 months are selective in their gaze following and will only follow the gaze of an inanimate object when it has 'eyes' and produces 'vocalizations' contingent upon the infant's, suggesting that the infants are reacting not just to plain animacy in other agents, but intentionality.

4.1.3 Task 3 – Using Common Ground for Reference Resolution

Another example of infants responding to the joint attention of others is following the gestures of those around us. Following deictic gesture shows a similar developmental pattern to following gaze. Before 9 months, infants are equally likely to fixate on the interlocutor's pointing hand than on their referent (Carpenter, et al., 1998), although by 12 months, infants are likely to fixate on quite distal targets of points (Lempers, 1976; Lempers, 1979). Infants start to use the interpretation of pointing to guide word learning at around 18 months (the same age at which they start to use gaze following to learn words, Briganti & Cohen, 2011). However, pointing is even more powerful in mapping words and objects in combination with gaze following as Booth, McGregor and Rohlfing (2008) showed superior recall amongst infants in word learning when an object was gazed and pointed at, rather than just merely gazed at.

What makes following pointing particularly interesting with regard to pragmatics is that infants have been shown to interpret points in ambiguous situations according to context and interlocutor knowledge, and with what some argue is a relation to a shared common ground. There is evidence that infants around 14 months operate with a knowledge of communicative intentions as demonstrated by object choice paradigms in which they select one of two opaque containers towards which the experimenter is gesturing (and gazing) as the container with a hidden toy inside (Behne, Carpenter, & Tomasello, 2005). At 18 months, infants have been shown to interpret the referent of a point based on a particular activity they shared with a specific experimenter so that their choice is based on ‘shared experience’. Similarly, Moll, Richter, Carpenter and Tomasello (2008) found that infants at this age interpreted a point as referring to an item that an experimenter had not seen and thus was ‘new information’ in the array and more salient for their interlocutor (see also Akhtar et al., 1996; Ganea & Saylor, 2007; Moll et al., 2008). What is particularly convincing about these studies is the differential behaviour of infants in their control groups for whom the “shared experience” had not been set up, implying that some evocation to a common ground was guiding their interpretation of the deictic gesture. However, to our knowledge, there has been no work to date on identifying individual differences in interpreting gesture and appeals to common ground.

4.1.4 Task 4 – Requesting and Repair

Communicative intentions with a declarative motive that represent showing and commenting are thought to be the preeminent example of pragmatic behaviour because they remove the possibility of a desire to obtain something. However, imperatives, such as requesting also have pragmatic aspects. A request is the attempt to change a situation, or bring about an event, using your interlocutor, and is thought by some to represent only an intention to obtain a goal. For example, some argue that the imperative point is simply a ritualised reach (Blake et al., 1994). However, Van der Groot et al. (2014) found that when presented with a desirable object, great apes would simply move closer to the object and perform instrumental actions to gain the help of another to obtain it. Infants at 12 months would instead stay distal to the object and use index pointing to direct attention to the object, despite having the opportunity to move closer as the great apes had.

Another reason requests are interesting is that they have been shown to vary differentially according to interlocutor knowledge state which is part of our essential criteria for pragmatics. O'Neill (1996) found that by the age of two, infants who had to request help from a parent in obtaining a toy from a high shelf that was out of reach varied their requesting behaviour according to whether the parent had witnessed the toy being placed on the shelf or not. Those whose parents were in the ignorant condition did significantly more naming of the toy and directing attention to the toy's location than those in the condition where the parent had been a co-witness to the hiding. The infant reacted differently according to whether the information was new to their interlocutor or was in their shared knowledge or common ground.

Similarly, Harding and Golinkoff (1979) found differences in requesting behaviour between infants who had been classified as having reached an illocutionary stage or not. They created what they term a communicative frustration episode (for example, a mother hiding a desirable object inside a tub that the infant was unable to open and then reading, essentially ignoring the infant and the scenario). Infants deemed to be communicating with illocutionary force directed vocalizations at their mothers' hands and eyes and combined vocalizations with other behaviours such as eye contact and gesture. Children not yet at the illocutionary stage did not direct their behaviours to the mother as an agent who they knew would help them open the tub and focused instead on the tub itself without trying to engage their mother to help.

These types of paradigms are interesting as they remove the typical scaffolding behaviour that caregivers would usually perform to support communicative and social interactions (Bruner, 1981) so that the child is completely alone, without cues or feedback and is forced initiate joint attention with their interlocutor by coordinating communicative behaviours into an effective imperative act. Related to requesting is the infant's proclivity to repair episodes of communication that have broken down. Golinkoff (1993) found that infants from 11 months, when they perform a communicative act and their caregiver appears to misunderstand, often engage in reparative behaviours, such as repetition, perseverance and elaboration (changing volume, combining modalities, i.e., a point and a vocalization, or changing modality). Some suggest that this behaviour can again simply be attributed to a desire to obtain an object, however infants still wish to repair miscommunication even when they have the object they were requesting (Grosse et al., 2010), and so we can again define requesting as pragmatic in certain scenarios (see Chapter 3, section 3.1.1.2, and Chapter 1, section 1.2.2 for further discussion).

4.1.2 Research Questions

The present chapter adapted experimental paradigms to create structured tasks tapping various potentially pragmatic skills, in order to:

1. Test whether they were suitable for administration in the home as structured tasks and whether they yielded sufficient variation for correlational analysis.
2. Test whether task performance correlated with infants' naturalistic expression of communicative intention, and their early formal language and gesture use as measured by parental report.

From previous findings, we made the following predictions for question 2, addressing performance on each task in turn:

Task 1 – Using Mutual Exclusivity for Reference Resolution

If socio-pragmatic accounts of the mutual exclusivity principle are correct (Clark, 1990; Diesendruck, 2005), we would expect to find positive correlations between performance on this task and on tasks that require the infant to take the context and interlocutor into account (Tasks 2 and 3 below), as well as naturalistic expression of communicative intentions. If leaner theories are correct and it is a specifically lexical principle, we would expect fewer correlations with pragmatic tasks and naturalistic expression of communicative intentions and only associations with measures of formal language (de Marchena et al., 2011; Graham et al., 1998).

Task 2 – Following Gaze for Reference Resolution

If gaze following is a “social criterion” (Baldwin, 1991), we would of course expect it to correlate with other socio-pragmatic behaviours. However, we may also expect a division between this and infant behaviours that initiate joint attention (i.e., naturalistic production of declaratives/comments) on the evidence of Mundy et., al (2007) who found dissociations on performance on responding to joint attention (i.e., gaze following) and the initiating of joint attention (i.e., infant showing). Finally, we could also expect a correlation between performance on this task and a measure of vocabulary size if infants use this strategy in determining form to object mappings and by doing so, are better equipped to learn words (cf studies which have linked gaze following with subsequent vocabulary development, see Brooks & Meltzoff (2005).

Task 3 – Using Common Ground for Reference Resolution

It is challenging to hypothesise whether we would expect to find individual differences in tasks that require the infant to appeal to information in common ground, such as what they and an interlocutor have experienced together, as extant work has focused on the development of experimental paradigms to elicit evidence that it is universally available, rather than individual differences. If it is a universal skill, we may expect it to correlate with all measures of naturalistic expression of communication intention and with the tasks if they represent rich socio-pragmatic abilities.

Task 4 – Requesting and Repair

We would expect performance on this task not to correlate with other pragmatic measures if initiating (IJA, declarative pointing and showing) and responding to joint attention (RJA, following points) are not associated as suggested by Mundy et., al (2007) since this is the only task in the battery that requires the infant to initiate joint attention to make a request. However, what is interesting about this particular task is that Mundy and colleagues did find within ages correlation between measures of initiating behaviour al requests (IBR, reaching, pointing and giving to make a request) and responding to behavioural requests (RBR, producing a toy on request and potentially gesturing). It is possible that Task 1 (using mutual exclusivity) and Task 2 (following gaze) could be tapping RBR, rather than RJA. It is also possible that this current task may be tapping IBR, rather than IJA. If this is the case, Tasks 1, 2 and 4 may correlate. Exploring association between this measure and the naturalistic communicative intentions may also prove illuminating to see if eliciting a request in this manner maps onto the production of requests during naturalistic play. We may also expect a correlation between this task and vocabulary size as IJA has been shown to correlate with future expressive vocabulary in particular (Morales et al., 1998).

Our results from the correlational analysis of naturalistic production of communicative intentions in Chapter 3 did not replicate the findings of Mundy et al. instead we found associations between nearly all intention types suggesting a related family of skills more in line with Tomasello's universal socio-cognitive model of joint attention wherein pragmatic behaviours may be expected to correlate (Carpenter, Nagell, et al., 1998; Tomasello, 1995). From this, we could expect the tasks to correlate differentially with the naturalistic measures as the former may reflect pragmatic competence, and the latter a global measure of motivation to communicate with variation in preference of intention type. All measures could feasibly correlate with concurrent emerging vocabulary skill if pragmatics-first approaches are correct which argue that a) word learning stems from pragmatic foundations that bootstrap the acquisition of language proper, and therefore b) the two skills do not develop in isolation.

4.2 Methods

See Chapter 2 for a detailed methodology for the collection of the naturalistic communicative intentions from naturalistic video play between infant and caregiver in our sample (including participant information and visit structure). Summarised below are the specific methods involved in administering each of the four pragmatic tasks.

4.2.1 Materials

For Tasks 1 and 2 (mutual exclusivity and referential gaze), materials included a toy wooden post box (24 x 10.5 x 15.5cm, Early Learning Centre) with an open slot for posting and a set of printed picture cards, made using cardboard and laminated. Images on the cards were of novel items taken the Novel Object & Unusual Name (NOUN) database (Horst, 2009). Task 3 involved three plastic instruments (piano, trumpet, guitar - Early Learning Centre), each depicting a face and with functioning buttons which played songs when pressed. Furthermore, each of the instruments made a noise when rattled or shaken. A guide for the caregiver on the correct layout of the instruments was made using a blank piece of material (a white pillow case), with outlines of the 3 instruments dawn on with marker to be used during the task. Task 4 involved a small plush toy model of a cat (Candy Cat from

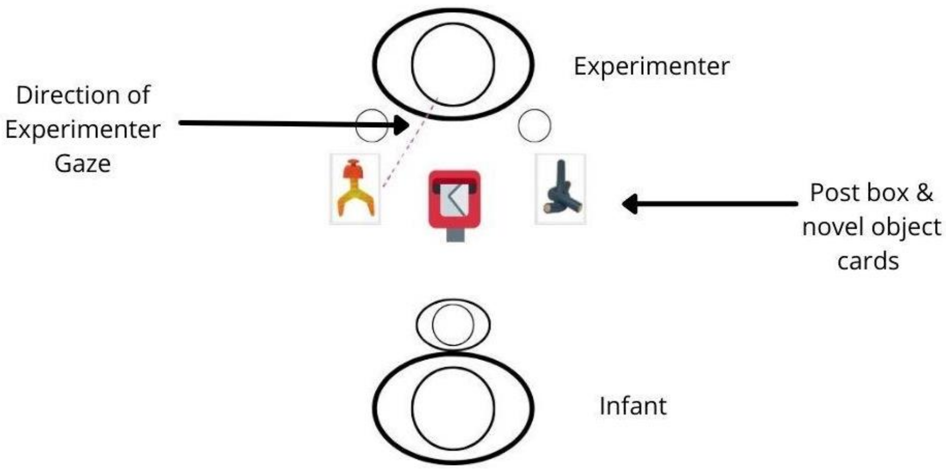
Peppa Pig) which made a meowing sound when squeezed, and a small opaque tub with a screw cap that could not be unscrewed by a child. All tasks were video recorded and coded at the Department of Psychology.

4.2.2 Measures

4.2.2.1 Tasks 1 and 2: Using Mutual Exclusivity and Following Gaze for Reference Resolution. Set up was identical for Tasks 1 and 2. Infant and caregiver were encouraged to sit on the floor in as clear a space as possible, with the infant sat either on the caregiver's lap or just in front of the caregiver. The experimenter then positioned herself directly in front of the dyad at roughly arm's length with the wooden post box in front of her and facing the infant (see Figure 11). After this point, procedure diverged for the two tasks:

Figure 11

Schematic for set up for tasks 1 and 2



Task 1 – Using Mutual Exclusivity for Reference Resolution. Methodologically, it is important to note that de Marchena et al. (2011) suggest that the widely used novelty paradigms as described in the preceding sections (which pit a familiar against a novel item) do not control for the infant's endogenous preference for novel objects (see also Horst et al., 2011). Instead, they developed an exclusivity paradigm (trialled with infants from the age of 2), in which two novel objects are presented, and one is explicitly named by the experimenter with a novel label. When infants hear a *second* novel label, they appear to appeal to the mutual exclusivity heuristic and select the second novel item as the referent (i.e., the one not already mapped to a label). They felt this paradigm presented clearer evidence of the use of inferential reasoning during disambiguation (and not just displaying preference for an exciting novel item they had never seen before) and so we adapted an exclusivity rather than a novelty paradigm according to the instructions below.

The caregiver was asked not to name any of the picture cards during the experiment but was encouraged to try to ensure the infant did not reach out and try to obtain the post box, and the warm up phase began. The experimenter laid two cards depicting familiar objects (on the ground in front of the dyad, just out of reach, and asked the infant to choose one or the other with a simple verbal prompt "where's the X?" Once the infant had chosen, they were encouraged to post the card they had chosen through the opening of the wooden post box and thus the warm up phase functioned as getting the child used to the 'posting game'. If the infant did not respond to the prompt within 10 seconds, the experimenter repeated her question. If the infant did not respond within another 10 seconds, the trial was considered invalid.

After 4 warm up trials (consisting of the following pairs, with target in bold; cat – **dog**, **apple** – banana, horse – **cow**, **teddy bear** – doll), the test phase began. The experimenter now presented the cards which depicted novel items from the Novel Object Unusual Noun database (NOUN; Horst, 2009) not simultaneously in front of the dyad as before, but in turn according to two conditions:

- **Named-unnamed: the first card is named and the second card is not**

  The experimenter showed the first card to the participant and said “oh look here’s the toma, look this is a toma, can you see the toma?”, whilst pointing to the card, then allowing the participant to take the card and play with it for a few seconds if they wished. Next, the experimenter took the card back (if the infant allowed it, in some cases, the infant became possessive over the card in which case the experimenter allowed the child to retain it), and showed the infant the second card and said “but wait, look at this, this is nice, look”. After a few seconds again, the experimenter took back the second card (or both the first and second if applicable), and presented them on the floor directly facing the infant at either side of the post-box whilst saying “where’s the modi? Can you put the modi in the box?” At the request, the experimenter did not look at or gesture to either card.

- **Unnamed-named: the first card is not named and the second card is**

  The experimenter showed the first card to the participant and said, “ooh, look at this, this is nice, look” whilst pointing to the card, then allowing the participant to take the card and play with it for a few seconds if they wished. Next, the experimenter took the card back (again, if the infant allowed it) and showed the infant the second card and said ““oh look here’s the blicket, look this is a blicket, can you see the blicket?”After a few seconds again, the experimenter took back the card (or both if applicable), and presented them on the floor directly facing the infant at either side of the post-box whilst saying “where’s the gazzer? Can you put the gazzer in the box?” At the request, the experimenter did not look at or gesture to either card.

Trials ran in the following order: Trial 1 = named (toma)-unnamed – target (modi) location on infant’s left; Trial 2 = unnamed-named (blicket) – target (gazer) location on infant’s left; Trial 3 = named (dax)-unnamed – target (kern) location on infant’s right; Trial 4 – unnamed-named (jick) – target (zav) location on infant’s right.

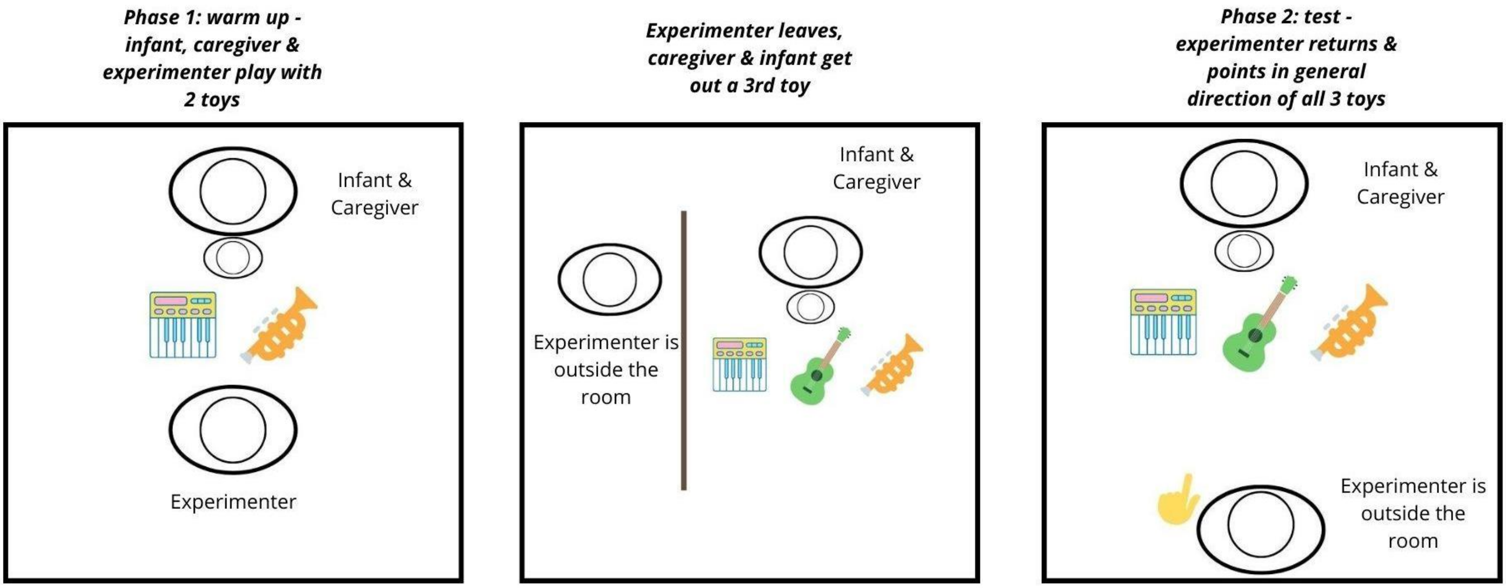
Task 2 – Following Gaze for Reference Resolution. The caregiver was instructed not to name any of the picture cards during the experiment. The experimenter held up two picture cards, one to each side of her face, then attracted the infant’s attention and established eye contact by calling their name. Once eye contact was established and infant gaze directed centrally to the experimenter, she asked the infant “where’s the X?” whilst glancing and turning their head slightly towards either one of the picture cards. If the infant did not respond within 10 seconds, the experimenter repeated her question. If the infant responded with a point or a reaching gesture, the experimenter gave the card to the infant and encouraged them to post it through the opening of the wooden post box (to encourage the infant to participate in the game during future trials). If the infant did not respond within another 10 seconds, the trial was considered invalid. This procedure was performed for four initial warm up trials with cards depicting pairs of already familiar objects (pair 1: pig-**monkey**, pair 1: **ball**-book, pair 3: girl-**boy**, pair 4: **flower**-star), objects in bold were explicitly labelled during the question and were the items looked at by the experimenter. Next, there were four test trials with cards depicting novel objects, all of which were different to the ones presented during the Mutual Exclusivity test. Novel labels were used at questioning phase to accompany experimenter gaze and head turn towards one of the cards (pair 1: yosp, pair 2: blick, pair 3: nurmy, pair 4: dawnoo). The target from each pair (i.e., the card towards which the experimenter turned her head) was located on infant’s left for warm up trials 1 and 3, and test trials 1 and 3, and on infant’s right for warm up trials 2 and 4, and test trials 2 and 4.

4.2.2.2 Task 3 Using Common Ground for Reference Resolution. This procedure had 3 phases (see Figure 12):

Phase 1: warm up. The experimenter sat on the floor facing the dyad and laid the piece of material on the ground in front of them upon which the outlines of the instruments had been traced in pen so as to be clearly visible to the caregiver. The experimenter placed an opaque bag containing three instruments by her side out of reach of the infant. First, the experimenter retrieved the piano toy and invited the infant and caregiver to take it and to play with it, encouraging the dyad to fully explore the instruments functions (i.e., pressing the buttons and shaking it) for about 30 seconds. After this, she retrieved the trumpet toy and repeated the procedure. If the infant was reluctant to relinquish the piano to play with the trumpet, the experimenter gently coaxed the infant. After sufficient play with the trumpet toy, the experimenter left the room and her bag with the caregiver, instructing them to get the final toy out, play with it as they had done before and when they were finished to line them up on the material as indicated by the drawn outlines. When exiting the room, the experimenter made it clear to the infant that they were leaving by saying “see you in a minute” and waving goodbye.

Figure 12

Schematic for set up for task 3



Phase 2: test. While the experimenter was out of the room, the caregiver retrieved the final instrument, the guitar, and proceeded to repeat the procedure as for the first two instruments. Next, the caregiver lined the instruments up as directed and placed the infant on their lap if possible, trying to ensure the infant did not reach for, or touch any of the instruments, until the experimenter was back in the room. Meanwhile, the experimenter, whilst visually absent, had been keeping watch through the door and came back in once the instruments were lined up. While re-entering the room, the experimenter immediately:

- Pointed in the rough/general direction of the material (not to any individual toy)
- Said excitedly "oh wow, look, can I have it? Can I have it please?"
- The experimenter repeated the question in the event of no response.

4.2.2.3 Task 4 – Requesting and Repair. This procedure had three distinct phases (see Figure 13):

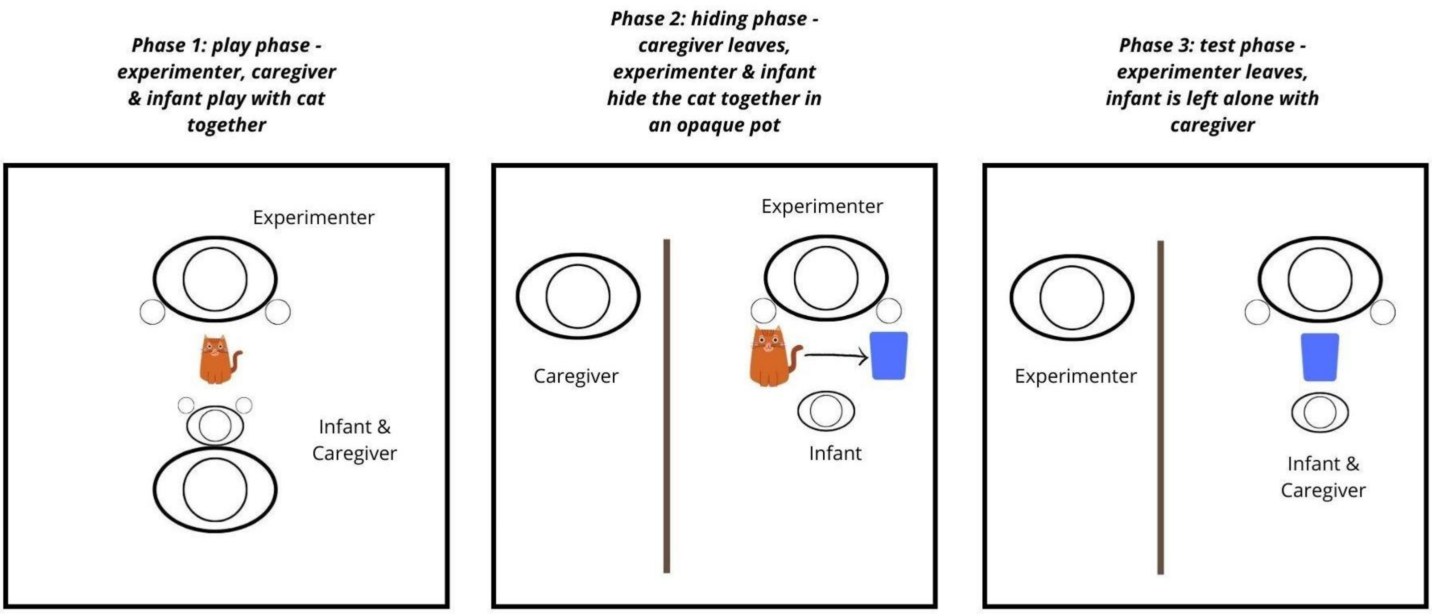
Phase 1: play phase (experimenter, infant and caregiver engage in play with an object together). The experimenter indicated that she had something to show the dyad and encouraged the infant and caregiver to sit on the floor directly in front. The experimenter then retrieved a stuffed toy cat from a closable opaque bag and handed it to the infant whilst saying "Oh look, it's a cat" ensuring to alternative gaze to the object and infant. If the infant was reluctant to take the cat for themselves, the experimenter held onto it, ensuring it was always visible to the infant. Next, the experimenter said "what does the cat say?" and encouraged the infant to make the toy "miaow" by squeezing it. Finally, the experimenter encouraged the infant to engage their caregiver in triadic communication by saying for example, "show mummy the cat".

*Phase 2: hiding phase (experimenter and infant work together to hide the object in the absence of the caregiver).*The experimenter then discreetly indicated to the caregiver that it was time for them to leave the room (this was agreed upon before the start of the experiment to minimise disruption), whilst distracting the infant by saying "ooh, what else is in my bag?" and looking into the opened, opaque bag. If the caregiver had indicated before the experiment that they were uncomfortable with leaving the room, it was agreed that the caregiver would stand in a corner of the room, clearly facing away and busied by some other task. If the infant became too distressed at the caregiver leaving the room, the test was abandoned. If the caregiver had managed to successfully leave the room, the experimenter then retrieved an opaque plastic tub from the bag, saying "shall we put the cat in here, while mummy is outside?". The experimenter then placed the cat inside the tub and secured the lid, making sure it was clear to the infant where the cat had gone. The experimenter then retrieved the cat and repeated the hiding procedure. Afterwards, the lid was fastened securely and the tub handed to the infant.

Phase 3: test phase (infant is left alone with 'ignorant' caregiver who has not seen the object hidden). Once the infant had the tub, the experimenter called the caregiver back to the room by saying loudly "oh, where's mummy gone, shall we shout mummy back?". As the caregiver re-entered the room, the experimenter left so the dyad could interact alone. Before the test began, caregivers had been instructed that when they re-entered the room to greet the infant and sit down, acting as normally as possible and not to immediately direct attention to the tub. If the infant tried to tell them something about the tub, they were to say "Oh, that's nice" so as to pretend they did not know the cat was inside. If the infant handed the tub to the caregiver, they were advised to hand it back to the infant after looking at it nonchalantly. The experimenter waited outside the room for 10 seconds, re-entering after that time. To finish the test, the experimenter said "shall we show mummy where the cat was?" and then helped the infant to retrieve the cat to show to the caregiver.

Figure 13

Schematic for set up for task 4



4.2.2.4 Parental Report of Gesture Use. Parent report of their infants' use of declarative and imperative gesture was measured using the Language Use Inventory (LUI; O'Neill, 2007), Part 1, Subscales A and B (see Appendix B; collected at home visit, see Chapter 2, section 2.2.1 for procedure).

4.2.2.5 Parental Report of Formal Language. Expressive and receptive vocabulary was measured using the Lincoln UK adaptation of the Bates McArthur Communicative Development Inventory (Infant Form; Meints, 2000).

4.2.3 Coding

Coding of the tasks was performed by the author using the video recordings of each task.

Tasks 1 & 2: Using Mutual Exclusivity and Following Gaze for Reference Resolution. For each of the 4 test trials, every infant was given either 1 for selecting the target item, 0 for selecting the non-target item, or NA if the trial was invalid. Selection by the infant was defined as gesturing or pointing to the target, picking up and posting the target, posting a card over another if infant has both in their hands, picking up the target and showing/giving it to the experimenter or caregiver. The infant's *first* selection (according to the above criteria) was always coded so for example, if they pointed to one and then to the other, the first point would be recorded.

Criteria for excluding trials was coded P1-3 (for various types of participant error, including fixating gaze or selecting an item pre-experimenter request, selecting or gesturing to both items at the same time, being non-responsive), E1-3 (for various types of experimenter error, such as violation of protocol, badly angled camera, and experimenter pointing to both items at once accidentally in an attempt to redirect the infant's attention), or CG1 (for caregiver error, usually caregiver intervening to help the infant select an item). If the infant had more than 1 invalid trial (coded NA), coding was discontinued and the participant not included. Occasionally, the experimenter repeated a label in an attempt to re-engage an infant of the cusp of disengagement, and so the number of times a label was repeated was also coded. Trial codes were converted to a percentage of correct answers out of valid trials (i.e., a score out of either 3 or 4 valid trials).

In sum, participants 1-30 in the study were either not tested while the tests were being developed or lost to piloting across all tasks. For Task 1 (using mutual exclusivity for reference resolution), a subset of 64 infants were tested. Of these, 37 had valid trials, and 27 were excluded from analysis due to infant disengagement (*n* = 11, codes P1-3 above), or experimenter error, including being offshoot of cameras (*n* = 12, codes E1-3 above). For Task 2 (following gaze for reference resolution), a subset of 68 infants were tested. Of these 38 had valid trials, and 30 were excluded from analysis due to infant disengagement (*n* = 25, codes P1-3 above), experimenter error (*n* = 5, codes E1-3 above).

Task 3: Using common ground for reference resolution. Every infant's test trial was coded either 1 if the infant selected the target item after experimenter request, 0 if the infant selected any non-target item after experimenter request, and NA if the trial was invalid. Selection by the infant was defined as either gesturing/pointing to the target, picking up the target, or showing/giving the target to experimenter or caregiver.

Also coded were the following:

- If trial was given a score of 0, the item the child picked up was recorded (was it the primary or secondary item)?
- Was the target item the last item that the dyad played with before experimenter return?

- Did the child visually register the experimenter leaving the room?
- After handing over an item after experimenter request, did the infant go immediately to the other items to hand them over as if still responding to the request?

Criteria for excluding trials was coded P1-4 (including if the infant was already touching any of the items after the experimenter re-entered the room, if the infant selected another irrelevant item in response to experimenter request, i.e. the bag that the instruments came in, if the infant was unresponsive to experimenter question or if the infant is in the wrong position when experimenter re-enters the room, i.e. with their back to the experimenter), E1 if the experimenter had made an error angling the camera so that coding was impossible, or CG1-2 (including if the caregiver intervened, gestured to any of the items, or invalidated the trial by not lining up the items correctly).

In sum, and as above, participants 1-30 in the study were either not tested while the tests were being developed or lost to piloting across all tasks. A subset of 66 infants were tested. Of these, 43 had valid trials, and 23 were excluded from analysis due to infant disengagement (*n* = 18, codes P1-4 above), experimenter error (*n* = 2, codes E1 above), and caregiver intervention (*n* = 3, codes CG1-2 above).

Task 4: Requesting and Repair. Coding this task was more similar to naturalistic coding than other structured tasks and measures comprised occurrences and types of behaviours during the period whilst the experimenter was out of the room and infant and caregiver were alone together (procedural phase 3). The occurrences and types were then translated into a composite score of pragmatic sophistication based on the Test of Pragmatic Skills (TOPS; Shulman, 1986).

The coder located the section on the video that marked procedural phase 3 i.e. the test phase by searching for the section where the experimenter left the room. Once the experimenter was comfortably out of shot visually and audibly, and the caregiver was back and seated comfortably, coding took place for the next 10 seconds. If at 10 seconds, the infant was on the cusp, or halfway into producing a communicative attempt, the window was extended to capture the full attempt. The coder recorded the following in order to reach a composite score:

- Binary communicative attempt score – i.e., was there a communicative attempt produced within 10 seconds?
- Was the infant's first communicative attempt a response to a caregiver utterance (usually something like 'what's that', 'what's inside'?), or was it initiative (as despite instructions some caregivers attempted to initiate communication as they entered the room)?
- A description of communicative attempts made within 10 seconds according to the categories below:
    - **Intention**: an intention was ascribed to the communicative act based on the TOPL-2 speech act coding list; requesting action, requesting information, responding, rejection/denial, informing, greeting.
    - **Modality**: a modality was ascribed to the communicative act; gestural, vocal verbal – if act was multi-modal, both types would be recorded
    - **Gloss**: a rough gloss was provided to the communicative act; for gestures, the gesture type and a description was recorded, i.e., give (tub to mum), point (to door), for vocalisations, a rough transcription was recorded, i.e., 'uh', noting any frustration or distress, and for verbal, the word or proto-word was recorded.

      Gaze check: whether the communicative act was accompanied by a gaze check to caregiver was recorded – 0 – no, 1 – yes.

Once each participant had been coded for the above, a composite score of pragmatic sophistication was assigned to each infant's communicative attempts during the test phase of the frustration episode. Coders were encouraged to make a judgement based on the level of infant response to the situation along the following lines:

- Score 0 = no communicative attempts in 10s
- Score 1 = communicative attempts made but these are contextually inappropriate, i.e., they do not concern the cat or tub
- Score 2 = communicative attempts are made that are contextually appropriate but have minimal gaze checking, minimal perseverance and minimal elaboration (i.e., infant attempts only once to engage caregiver, or does so without gaze checking, focused only on trying to manipulate the tub themselves)
- Score 3 = communicative attempts are made that are contextually appropriate with gaze checking, perseverance and elaboration (i.e., infant has multiple attempts, elaborates by switching to different techniques, multiple gaze checks)

Criteria for excluding trials was coded E1 for experimenter camera error, P1 and P2 for infant refusal to engage after or before the test phase respectively, and CG1 for caregiver invalidating trial by opening the tub.

Finally, and as above, participants 1-30 in the study were either not tested while the tests were being developed or lost to piloting across all tasks. A total of 78 infants were tested. Of these, 25 were excluded from analysis due to infant disengagement (n = 11, codes P1-2 above), caregiver violating protocol (n = 5, code CG1 above), or the infant and caregiver going offshot of the cameras at the test phase (n = 9, code E1 above).

4.2.4 Approach to Analysis

To test for associations between the pragmatic tasks, naturalistic measures and parental report, non-parametric correlational methods were performed since most variables were not normally distributed.

4.3 Results

In this section, we first consider the value of the pragmatic tasks we used as measures of individual differences. We report statistics concerning whether children performed above chance as a group (where appropriate) and qualitative impressions of the validity of each task. We also consider the extent of missing data, whether it was missing at random and whether the chance of not completing a trial was associated with gender and experimental condition (this cohort was originally part of a randomised controlled trial to assess a parenting intervention, see Chapter 2, section 2.1). On this basis, we retained two of the four tasks for further analysis (task 2 following gaze for reference resolution and task 4 requesting and repair). At this stage, the dataset was split into a subset who participated in task 2 (following gaze for reference resolution) and a subset task 4 (Informative Requesting) and separate correlations were carried out for each subset. This is because the subsets of infants who participated in each task were not the same. Finally, we consider the extent to which these pragmatic tasks correlate with a naturalistic measure of the frequency of expression of communicative intentions, and concurrent parental report measures of gesture and formal language use.

4.4.1 Task Feasibility

In this section we assess each of the pragmatic tasks in turn for their suitability for administration in a home setting and make decision on whether they should be included in subsequent analyses.

4.4.1.1 Task 1 – Using Mutual Exclusivity for Reference Resolution. A single sample t-test showed that performance on the mutual exclusivity task was not above chance (*t*(38)=.046, *p* =.964), and the median (.50) and mean (0.50) scores suggest that most infants were acting at random in a forced choice scenario. As discussed in the methodology, an exclusivity paradigm (where two novel objects are used) was chosen as the use of a known and a novel item can lead to novelty effects. However, the current findings suggest that this exclusivity paradigm is too demanding for most 18-month-olds. The investigator's qualitative impression was also that the distribution of scores is likely to have been obtained by chance and so it is not the case that higher scores necessarily represented greater ability. We therefore decided that the paradigm was not developmentally appropriate, and we excluded this test from further analysis. For the exclusivity paradigm to work with infants at 18 months significant adaptations should be made and will be discussed further in section 4.4.

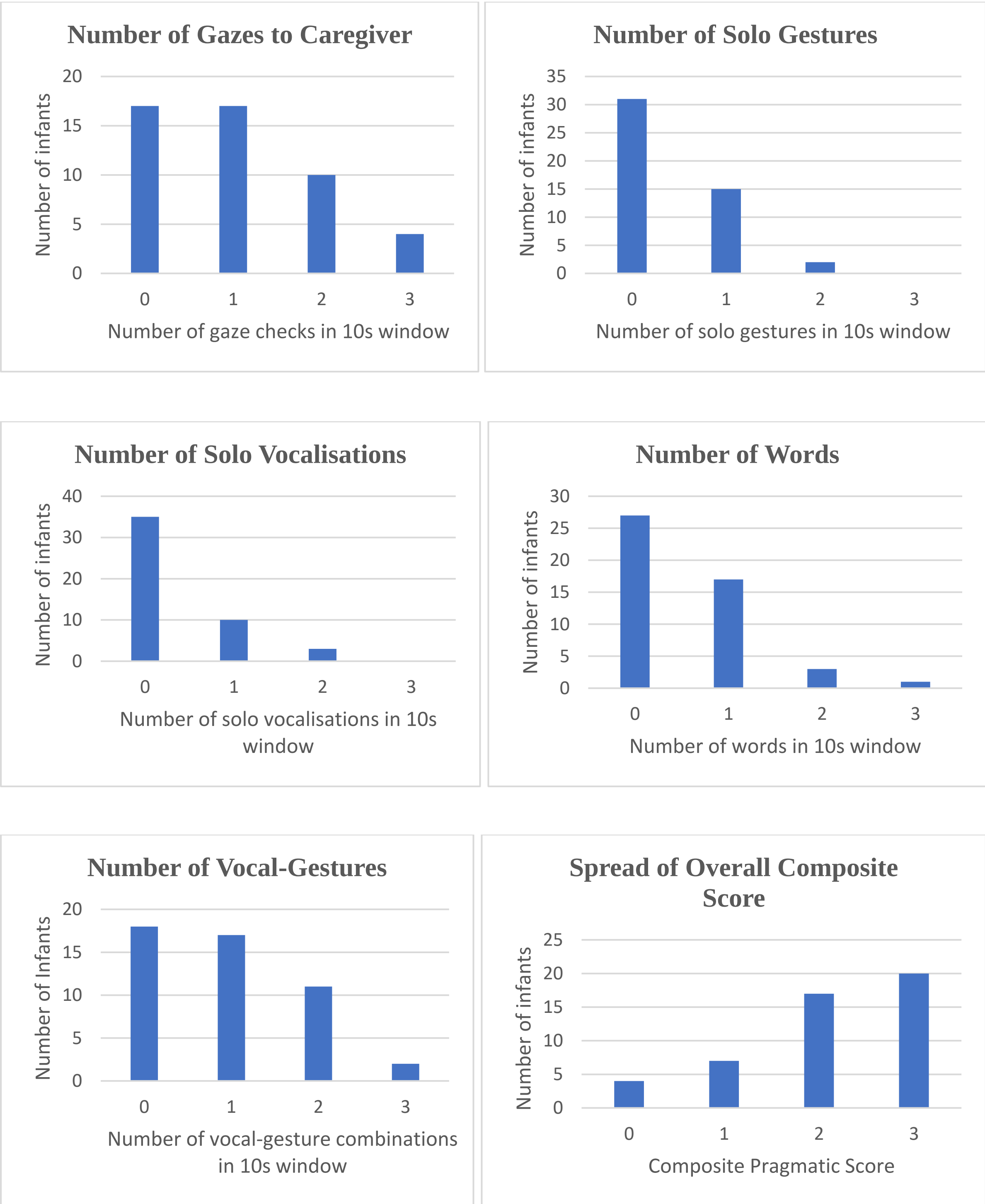
4.4.1.2 Task 2 – Following Gaze for Reference Resolution. A single sample t-test showed that infants performed significantly above chance on this task $t(40)=3.31$, $p=.002$, meaning that when presented with two objects, one of which the experimenter was looking at while asking for a novel item, as a group children would chose the looked-at item. Thirty eight infants contributed data for this measure. To test whether data was missing at random or not, chi-squared tests of independences were run and no significant associations were found with gender ($\chi2\ (1)=1.06$, $p=.301$) or experimental condition ($\chi2\ (1)=1.33$, $p=.247$). Correlation coefficients (Pearson's r) showed no significant associations with age or the infants' socioeconomic background (SES). The full range of SES deciles were represented for the children contributing data (30% most deprived LSOAs n =17, middle 30% LSOAs n =17, 30% least deprived LSOAs deciles n =20). Therefore, we assumed data for the referential gaze task was missing at random. An independent samples t-test showed that female infants (N = 23, M=.774) performed significantly better higher than male infants (n = 17, M =553) ;$t(39)=-2.039$, p=.48) on the task. Furthermore, and contrary to any expectation, children who originally received a language intervention performed worse (*M* =.558) than those in the control condition (*M* = .801); $t(39)=2.315$, p =.026).

4.4.1.3 Task 3 – Using Common Ground for Reference Resolution. Infants performed significantly above chance (0.33) on this task $t(42)=2.01$, p =.050). The sample was roughly split 50/50 as to whether they selected the target item or one of two alternative options (target item n = 21, non-target item selected n = 22). When running the task in the home however, it became clear that selecting a non-target item was not necessarily pragmatically infelicitous. We expected children to select the novel item that the experimenter had not played with before. However, it was possible that they would choose a given item on the basis that it was in common ground. Furthermore, during video coding, we observed that around a quarter of the infants (26%) returned to the array immediately after their initial selection to pick up a second or third instrument as if their response to the experimenter request was not finished. We also considered our version of the task too methodologically dissimilar to the original experiment in that we did not run any pre-tests for object preference, the position of object was not counterbalanced between trials and we had no controls as to the willingness of the infant to hand something over, meaning it would be erroneous to suggest we either did to did nor replicate the paradigm. For these reasons, we excluded this task from further analysis.

4.4.1.4 Task 4 – Requesting and Repair. This task was successful in eliciting naturalistic communicative behaviour from a larger number of infants (n = 48). As described in the method, a composite score was arrived at taking into account pragmatic sophistication of the infant's requesting behaviour (indexing gaze, speech acts, perseverance and elaboration). However, for descriptive purposes, we present in Figure 14, the distribution for the individual behaviours that were taken together to yield the composite score. As can be seen, children differed considerably in the extent to which they checked the gaze of their caregiver, gestured, vocalised, produced words and combinations of these behaviours. Unlike some of the forced choice tasks, it is safe to assume that higher scores represent greater pragmatic ability. Not all infants contributed to the data. To test whether data was missing at random or not, chi-squared tests of independences were run and no significant associations were found with experimental condition ($\chi 2$ (1)=1.28, p =.128), but a near significant association was found with gender ($\chi 2$ (1)=3.64, p =.056), with female infants more likely to have valid trials than males. Correlation coefficients (Pearson's r) showed no significant associations with age or SES.

Figure 14

Descriptive Statistics for individual behaviours in Task 4 Request and repair



4.4.1.5 Parent Report of Gesture Use. There was relatively little variance in parents' reports of their child's use of gesture for communicative purposes using the Language Use

Inventory (LUI' O'Neill, 2009). The majority of children were at ceiling on both the use of imperative and declarative gesture (Part 1, Subscales A and B). However, we include it in future analyses as a substantial minority were not at ceiling and we assume parent report to be a reliable measure of communication difficulties.

Table 9

Descriptive Statistics for Pragmatic Tasks and Imperative and Declarative Gesture Use

	Minimum	Maximum	Mean	SD
Following gaze for reference resolution (Proportion of trials out of 4)	0	1	.68	.369
Request and repair (Score out of 3)	0	3	2.12	.931
Imperative Gesture Use (LUI) (Score Out of 11)	4	11	9.74	1.603
Declarative Gesture Use (LUI) (Score out of 2)	0	2	1.91	.330

4.4.2 Task Performance and Naturalistic Expression of Communication Intention

Performance on task 2 (following gaze for reference resolution) and task 4 (request and repair) showed a weak positive, but not significant correlation (r_s = .228). Table 10 presents correlations between performance on the pragmatic tasks, the naturalistic measures and the parental report of gesture use and expressive and receptive vocabulary. Furthermore, the dataset was split into a subset who participated in task 2 (following gaze for reference resolution) and a subset task 4 (Informative Requesting) and separate correlations were carried out for each subset. This is because the subsets of infants who participated in each task were not the same.

Table 10

Correlation Coefficients (Spearman's rho) for Performance on Pragmatic Tasks, Naturalistic Measures and Parental Report

	Task 2 (Following gaze for reference resolution) *n* = 38	Task 4 (Requesting and repair) *n* = 48
Comments (from Naturalistic data)	.123	.421**
Requests (from Naturalistic data)	-.338*	.199
Answers (from Naturalistic data)	.246	.316*
Acknowledgements (from Naturalistic data)	.204	.192
Expressive vocabulary (Parental Report; LCDI)	.194	.229
Receptive vocabulary (Parental Report; LCDI)	.284	.065
Imperative gestures (Parental Report LUI)	.301	-.207
Declarative gestures (Parental Report; LUI)	.219	.104

*$p<0.05$

**$p<0.01$

4.4 Discussion

The study presented here aimed to establish whether a set of tasks could be used to measure individual differences in the communicative ability of a cohort of 18-month-olds in a home setting, and, for viable tasks, to test for associations with naturalistic measures of the communicative acts the infant produced in structured play with their caregiver and with parental report measures of gesture use and formal language. There were two main findings corresponding to our two research questions.

4.4.1 Are the Pragmatic Tasks Suitable for Administration in the Home, and Do They Yield Sufficient Variation for Correlational Analysis?

Firstly, all pragmatic tasks showed variability in performance suggesting that these measures are not universally in situ as preferred communicative strategies at 18 months. However, only variability in Task 2 (following gaze for reference resolution) and Task 4 (requesting and repair) was thought to be meaningful. Differences in performance in Task 1 (using mutual exclusivity for reference resolution) looked to be at chance suggesting that an exclusivity paradigm (asking the infant to choose between two novel items) is too cognitively demanding for 18-month-olds. While we agree with de Marchena et al (2011) that novelty paradigms (choosing between a novel and *familiar* item) are problematic in not accounting for infant endogenous preference for novelty, an exclusivity paradigm still requires significant adaptation to become developmentally appropriate for this age group. A task that is less demanding in terms of language processing and memory could resolve this, perhaps by using preferential looking (i.e., Mather & Plunkett, 2010). Variability in Task 3 (using common ground for reference resolution) was also difficult to interpret as it was unclear in the context why the infant's choice of one toy was more pragmatically motivated than any other. While infants have been shown to select a referent that is novel to an interlocutor in response to an ambiguous request (with positive affect), the authors of the original paradigm (Moll et al., 2008) suggest that in a laboratory setting, what is clearly in common ground between the infant and the experimenter is *a shared visual experience.* However, in a less controlled environment (as in the infant's home), it is difficult to argue that what was not in common ground for some infants was the instrument that was played with first (therefore, some kind of primacy effect), or their own favourite. Furthermore, a pre-test based on the one performed by Moll and colleagues (2007) establish which infants were willing/unwilling to respond at all was not carried out prior to the actual test due to time constraints.

Of all the tasks, it was felt that Task 4 (requesting and repair) showed particular ecological validity in that it elicited variability in a wide range of pragmatic behaviours in just 10 seconds, and that during the crucial 10 seconds, infants were communicating with their caregivers at home and not with a stranger in the laboratory (unlike similar tasks on the Early Social Communication Scales; Mundy et al. 2003). However, the amount of missing data overall raises concern. Although the data was shown to be missing at random (as far as the variables we explored was concerned at least), adaptation is clearly needed to make it more appealing to 18-month-olds and more robust to delivery in a home setting. One of the major reasons for invalid trials on Task 4 (*n* = 9) was the positioning of cameras and we found that when the caregiver came back in, the infant tended to move towards them thus moving from the position where they had interacted with the researcher (and therefore out of shot). More careful camera placement in the home could yield a higher number of valid trials.

4.4.2 Is Task Performance Correlated With Infants' Naturalistic Expression of Communicative Intention, and Their Early Formal Language and Gesture Use as Measured by Parental Report?

The second main finding concerns the associations between performance on pragmatic tasks and naturalistic measures. Firstly, infants who produced more naturalistic requests showed poorer performance in following the experimenter's gaze in Task 2 (following gaze for reference resolution). This appears to align with Mundy et al. (2007) findings that performance on their responding to joint attention subtask (RJA, e.g., following a point) did not correlate with their measures of initiating behavioural requests (IBR, e.g., asking for help winding up a toy), which in our naturalistic measures would correspond with the production of requests (imperative motive). Interestingly, the requests produced naturalistically in our sample were most likely out of all of the intention types to be accompanied by a gaze to the caregiver (30.5%). However, in a naturalistically expressed request, infants are using gaze to initiate joint attention for imperative purposes, whereas in the task, they are following gaze to respond to joint attention. It could be that following gaze in the task represents a more social function (Baldwin, 1991), or even an understanding of others as attentional and intentional beings (Tomasello, 2010), whereas naturalistically expressed requests could be more instrumental in the rapid exchange of everyday interaction (Moore & Corkum, 1994). It was surprising to note that Task 2 (following gaze for reference resolution) correlated weakly with both concurrent expressive or receptive vocabulary, and not significantly, particularly as early gaze following predicts later language (Brooks & Meltzoff, 2005, 2008). There was variability on performance, suggesting that gaze is not an ostensive, referential signal for all infants equally (Akhtar & Gernsbacher, 2008).

If in eliciting infant requests to access a toy, Task 4 (requesting and repair) is a measure of IBR (initiating behavioural requests), we may expect to see only correlation with the requesting and responsive naturalistic communicative intentions, following the results of Mundy et al. (2007) who found positive correlation between infant performance on tasks tapping the ability to initiate (IBR, e.g., asking for help to wind up a toy or help in unscrewing a lid) and to respond to behavioural requests (RBR e.g. providing an object when asked). This was in part borne out in a weak but significant correlation between Task 4 performance and the naturalistic production of the responsive act answering. However, we saw a more significant and moderate association between Task 4 performance and naturalistic production of *comments* which does not replicate Mundy's findings of disassociation between initiating joint attention (declarative pointing and showing) and IBR. This could feasibly be down to the difference in methods between Task 4 here and the ESCS IBR task. The ESCS IBR task is an elicitation of infants' requests for help in winding up a toy or gaining help to unscrew a lid that codes for eye contact, reaching, points, gives and appeals (the latter being specific behaviours that might help the infant to obtain the object such as slapping the table, moving their fingers towards the object or vocalizing loudly). Our Task 4 could be thought to tap a slightly richer understanding of requesting, by introducing a) an interlocutor who had not seen the hiding process, and thus had a different knowledge state to the infant, and b) communicative frustration though an interlocutor who does not immediately respond to the infants' requests, in turn provoking repair mechanisms and perseverance from the infant. It could be that a) encourages the infant to comment and show *in the declarative motive*, as well as to request, and b) produces the requisite delay between request and obtaining the object, that the infant engages in a number of communicative intentions with differing underlying pathways. The correlation with the naturalistic expression of comments, arguably the most social of the intention types (in that it requires the sharing of attention and not the fulfilment of an instrumental purpose) could make this a viable alternative to naturalistic methods of capturing the motivation to communicate and connect with others.

We found no significant correlation between Task 4 and expressive and receptive vocabulary, i.e. no significant association between a larger vocabulary as measured by parental report and a higher score of pragmatic sophistication during the 10-second 'communicative frustration' task window (requiring contextually appropriate communication, using gaze, perseverance and elaboration, see Section 4.2.3). This may be explainable by the fact that less than half of the infants produced a word to engage their caregiver during the 10-second 'frustration' window suggesting that formal language was not the only route to a higher pragmatic score, with infants instead often choosing to use gaze, idiosyncratic vocalisations, gesture and combinations of these. Finally, the two pragmatic tasks themselves showed a weak but non-significant correlation which fits with the existing literature on the separability on RJA and IJA/IBR. There were two further interesting observations for the Task 2 (following gaze for reference resolution). Firstly, female infants were much more likely to have high scores on the task. We know that female infants are more likely to orient to the direction of others gaze than male infants (Lutchmaya & Baron-Cohen, 2002), and this also corresponded with our findings from Chapter 3 that female infants coordinated their naturalistic communicate acts with gaze to their caregiver significantly more than male infants in the sample. Unexpectedly, we found that those who had been part of the intervention condition to promote caregiver contingent communication were more likely to have a worse score.

Overall, it can be said that running structured tests of communicative ability with toddlers in the home is challenging. Nonetheless two of the tasks seemed to generate meaningful data, albeit with several missing cases. Variability in performance on these pragmatic tasks at 18 months was related to some types of communicative intention expressed by the infant in a naturalistic unstructured play setting. Given the exploratory nature of this study, this would need to be replicated with a second, larger sample to draw any firm conclusions. Of all the tasks, Task 4 (requesting and repair) showed the most promise and appears to have elicited more advanced pragmatic behaviour than the equivalent task in the ESCS battery which does not involve an ignorant partner, requires a far more elaborate set up and involves the infant interacting with a stranger in the test window, rather than their own caregiver.

5. Environmental Influences on the Expression of Communicative Intentions and Formal Language at 18 months

Abstract

The present Chapter aims to address a widely acknowledged gap in our understanding of how the development of socio-pragmatic ability in infancy relates to factors in their environment. To do so, we explored potential environmental influences on a) infants' naturalistic expression of communicative intentions (intentions such as comments, requests, answers, and acknowledgements), b) the frequency with which infants expressed these intentions in the vocal, gestural, combined vocal-gestural and gaze coordinated modalities, and c) on their formal language ability (expressive and receptive vocabularies). Measures of the environment (or proxies thereof) included multiple indices of socioeconomic status (SES: i.e., caregiver education, household income and deprivation), a quantitative measure of caregiver input (adult word count), and an indicator of the caregiver's beliefs about their role in their child's development of various pragmatic skills.

Firstly, we found that all measures of SES, (caregiver education, annual income and a deprivation score based on family neighbourhood) were positively correlated, but there were no significant correlations between adult word count and the SES measures. Interestingly, there was a *negative* significant correlation between the amount of responsibility the caregiver reported they felt in the teaching of a host of pragmatic abilities and SES measures. Secondly, we found significant associations between caregiver input (adult word count), and total frequency of infant intentional acts, as well as the frequency with which they expressed comments, answers, and acknowledgements, but not requests. Answers and acknowledgements showed association with household annual income (and answers with education), but no other SES measures. Furthermore, measures of expressive and receptive vocabulary significantly correlated with all measures of SES, as well as with adult word

count. These results suggest that the social gradient normally observed in the lexical domain during development is also observed to some degree at the *functional* level, in infants' expression of communicative intentions in everyday interaction.

Finally, since the participants in our sample had been previously assigned to either a control condition (*n* = 48) or intervention condition (*n* = 56) as part of a randomised controlled trial (RCT) to test the efficacy of a language-based intervention designed to increase caregiver semantic contingency, we ran the same analyses on the subset who had received the intervention and found no significant social gradient in a) the frequency of expression of communicative intentions, b) whether these intentions were expressed vocally, gesturally, vocal-gesturally or with gaze or c) expressive or receptive vocabulary, suggesting that an intervention designed to increase caregiver contingency neutralised environmental effects at 18 months.

5.1 Introduction

Chapters 3 and 4 were concerned with exploring associations and dissociations between proposed subdomains of communicative ability in infancy. In doing so, we hoped to provide a window onto potentially common underlying structures and processes, thereby addressed the so-called 'architectural imperative' (Kidd et al., 2018). The present Chapter is motivated instead by the '*environmental* imperative' (Kidd et al., 2018; Kline et al., 2018) which argues that we must also account for observed relationships between individual differences in communicative development and variation in aspects of the infants' environments, such as indicators of the family's socioeconomic status (SES) and the quantity and quality of linguistic input from the caregiver. Certainly, for sociocultural and ecological theories of development, learning to communicate is the result of bi-directional influences resulting from interactions between all properties of a child's surrounding environment, ranging from the proximal to the distal, from the child's behaviour and temperament, to the caregiver’s interaction style and belief system, all the way to broader cultural values and prevalent ideologies in wider society (for a summary, see Chapter 1, section 1.3.3; Bronfenbrenner, 1977; Vygotsky, 1978). Therefore, if we want to gain a full understanding of communicative development, it is crucial to study the process in its environmental context, and much valuable work has done exactly this.

For example, it is well established that infants’ early formal language development is associated with differences in their broader socioeconomic environment, with SES correlating positively with infants’ expressive and receptive vocabulary (Arriaga et al., 1998; Dollaghan et al., 1999; Fernald et al., 2013; Hart & Risley, 1995), and grammatical complexity (Hirsh-Pasek et al., 2015; Huttenlocher et al., 2010; Vasilyeva et al., 2008). There are also socioeconomically mediated disparities in their immediate language environments which can either boost or hinder word learning, with positive associations between SES and the frequency and diversity of Child Directed Speech (CDS: Hart & Risley, 1995), and the caregiver’s tendency to talk in way that is semantically contingent upon what the infant is interested in (Hoff, 2003; McGillion, et al., 2017). Early individual differences across the lexical and syntactic domains in infancy are thought to generate significant downstream effects as children enter school (F. Field, 2010; Hoff, 2013), on their literacy levels (Snowling & Hulme, 2012), academic achievement (McCormack et al., 2011), social skills, and then later on in higher educational and employment trajectories (Clegg et al., 1999; Johnson et al., 2010). Understanding the nature of the relationship between social disadvantage, formal language ability and life outcomes is clearly important, and given the costs of language based disparities to the individual and society, it is increasingly seen as an urgent public health concern (Law & Levickis, 2018).

However, although evidence of comparable adverse outcomes are starting to emerge for children with poorer skills in the *pragmatic* domain (Barbarin, 2013; Carpendale &

Lewis, 2004; Ketelaars et al., 2010; Troia, 2011), our understanding of the socioeconomic and environmental determinants of pragmatic ability is much less complete (Hyter et al., 2015; O'Neill, 2014). Since pragmatics is considered integral to the acquisition of language proper (Bates, 1976), and crucial to communication generally (Levinson, 2019; Tomasello, 2010), we argue that a picture of the impact of SES on communicative development will remain incomplete until we factor in the types of individual differences in early use of communicative intention we observed in Chapter 3 (where we demonstrated that at 18 months, infants varied in their naturalistic expression of various intention types in order to connect with others and 'get things done' in a naturalistic setting).

Using this variation in the use of communicative intention as our primary outcome measure, we will expand upon the relatively few extant studies looking for associations between environmental influences and developing pragmatic abilities in two main ways. Firstly, the majority of prior work in this area has either focused exclusively on complex and later emerging skills (such as implicature, irony and deceit; Antoniou & Katsos, 2017; Bosco et al., 2013; Schulze & Saalbach, 2021), or used naturalistic techniques to functionally analyse the speech of older children once formal language is in situ (Fannin et al., 2018; Tough, 1977). With a social gradient apparent in expressive vocabulary as early as 18 months (Fernald et al., 2013), we will explore whether this is replicated on a functional, *pragmatic* level, while the infant is not operating on a fully verbal level. This is an important question as the emphasis on words as the primary measure of infant and caregiver communicative ability may at best miss strengths on other levels (Rogoff et al., 2017), and at worst represent testing methods and interventions that are inequitable across the SES spectrum for communities that simply have a *different* approach to communication, and not a deficient one (Avineri et al., 2015; Fazio et al., 1996; Heath, 1982; Kline et al., 2018; Labov, 1970; Sperry et al., 2019). Secondly, we aim to counter the lack of socioeconomic representativeness in individual differences studies (often conceded by the authors; Mundy et al., 2007; Schulze & Saalbach, 2021) with a sample that is diverse and which spans a range of SES measures (including education, income, deprivation).

The following review section splits largely into two parts. The first begins by defining and operationalising SES, before moving on to consider various pathways of influence through which SES can be thought to operate indirectly (namely through caregiver input and beliefs). The second explores what we already know about the relationship between various measures of SES and communicative development in infancy, highlighting specific gaps in our knowledge of the association between SES and pragmatic development.

5.1.1 Defining Socioeconomic Status

Socioeconomic status (SES) is a construct commonly used as a proxy for environmental influences on a wide range of developmental processes (Bradley & Corwyn, 2002). It is usually defined as the various resources or capital available to an individual and the value these carry in society (Duncan et al., 2015; Entwislea & Astone, 1994; Mueller & Parcel, 1981), and as such can be indexed in multiple ways (Oakes & Rossi, 2003). For Coleman (1988), SES comprises three types of capital which map onto the most common SES measures used in developmental studies. Firstly, economic capital relates to wealth and is measured by household income. Economic capital affords a direct developmental advantage by allowing for provision of resources such as food and clothing, but also those that scaffold learning such as toys and books). Secondly, human capital pertains to non-material resources that shape the learning environment for child development, such as levels of caregiver education, caregiver’s linguistic ability and their experiences and beliefs. Thirdly, social capital relates to the family’s position in, and interactions with, their community and society, which in turn define their access to schools, housing, healthcare and neighbourhood safety. In the UK, it can be broadly indexed by measures such as caregiver occupation and the English Indices of Multiple Deprivation (Smith et al., 2019).

5.1.1.1 Selecting Indicators of Socioeconomic Status. The relationship between SES and a range of developmental outcomes is robust and well researched (McLoyd, 1998; Wickham et al., 2016), and *particularly* so for language outcomes (Conger & Donnellan, 2007). Despite this, there has been little agreement as to which of the economic, human or social proxies for SES are the optimal single predictor for language ability (Bornstein & Bradley, 2003). For some, caregiver education (a form of human capital) is the most useful single indicator and shows a robust association with vocabulary (Hoff & Naigles, 2002; Magnuson et al., 2009; Rindermann & Baumeister, 2015), while others have demonstrated a strong link between financial capital and language outcomes (BrooksGunn & Duncan, 1997). Measures of social capital are less commonly used (Ensminger et al., 2003), but 'neighbourhood' effects have been found (McLoyd, 1998). In a recent study of a large cohort of British Children participating in the Millennium Cohort study found that while several measures of SES predicted unique variance in childhood vocabulary across development to some degree, caregiver education, closely followed by income and occupation, consistently explained most variance (Thornton et al., 2021). In this study, a single variable collapsing all measures into one explained more variance than any single predictor alone. However, since all measures explained some unique variance it was recommended to consider at least the three most important SES indicators where possible.

In a similar vein, Liberatos et al. (1988) propose a number of solutions for selecting appropriate measures, including choosing those with the most conceptual relevance to the dependent variable in question (i.e. caregiver education for cognitive outcomes), but they also recommend using more than one single factor, with all forms of capital the most preferable. Debates on optimal operationalisation aside, the association between an infants' environment and their development is clear. The following section goes onto consider how SES exerts influence on development, namely through caregiver linguistic input and their own beliefs about development and language.

5.1.2 Pathways of Socioeconomic Influence.

The literature above indicates that SES is likely to be causing variation in infants' early environments and experiences that is influencing their communicative development. However, the various measures of SES are unlikely to do so directly. Instead, there are a number of pathways through which SES is thought to influence development indirectly. Below we detail two that are thought to be most pertinent to communication, a) the nature of caregiver's linguistic input, and b) their beliefs about parenting, which may well act upon a).

5.1.2.1 Socioeconomic Status and Caregiver Linguistic Input. There are well established differences in how caregivers from different socioeconomic backgrounds talk to their infants (i.e., the type of linguistic input they provide). Hart and Risley (1995) famously demonstrated that children from lower SES families by the age of four years old had heard 30 million fewer words than their higher SES peers (tokens not types), sparking intense media attention, and political and philanthropic initiatives aimed at closing the gap (Sperry et al., 2019). Their findings were replicated and enhanced by studies that showed that it was specifically these differences in parental linguistic input which mediated the effects of SES (Hoff, 2003; Huttenlocher et al., 2010). However, for many, their methods were not nuanced or representative enough (Avineri et al., 2015). For example, if the measure of the input is broadened to include not only maternal speech specifically directed to the child, but all language in their immediate environment (so as to capture the speech of multiple caregivers, extended family members and bystanders), the word gap disappears (Dailey & Bergelson, 2021; Sperry et al., 2019).

Many have also argued that the key differentiating factor is not one of quantity, but quality. Parents from lower SES backgrounds are thought to display an interaction style that has been characterised as less responsive and sensitive to infants' focus of attention (Conger & Donnellan, 2007; Flynn & Masur, 2007; Tamis-LeMonda et al., 2001), and in a functional analysis of caregiver talk, Fannin et al. (2018) found that lower SES was associated with more directing of infants and less responding to them. They related this to the concept of an "active-restrictive" parenting style associated with social disadvantage (Coolahan et al., 2002; Flynn & Masur, 2007; Hart & Risley, 1995; Masur et al., 2005).

Furthermore, the speech of mothers from higher SES backgrounds has been found to be richer and more diverse (Hoff, 2003), and crucially more contingent upon what the infant is currently attending to (i.e., labelling what the infant is looking at). This type of contingency is likely to facilitate the mapping between a word and its function and studies have shown that it does in fact account for observed SES differences in infant vocabulary (Hoff, 2003; McGillion et al., 2017). At 11 months, the infants in our sample had been recruited to take part in a randomised controlled trial (RCT) to test the efficacy of an intervention designed to increase caregivers' contingency by asking them to spend 15 minutes a day paying attention to what their infant is interested in and talking to them about it. Infants were either assigned to the contingency intervention condition, or a dental health control condition designed to improve toothbrushing techniques. At baseline, the number of words caregivers spoke to their infant during a 15-minute play session did not differ according to SES (a composite of education, income and a measure of neighbourhood deprivation), however the percentage of caregiver speech that was contingent upon what their infant was currently attending to did show a social gradient. Infant communicative behaviour at baseline did not differ according to SES (vocalisations, points, gaze following and expressive vocabulary). At a post-test one month after the initial administration of the intervention and control, caregivers in the semantic contingency intervention condition showed an increase in their contingent speech and in word types during play across all SES groups. However, infants in lower SES groups had bigger vocabularies at 18 months indicating that the intervention effects were particularly strong for lower SES infants. Infants at 18 months who had received the intervention were 4 months ahead of their peers in the control condition. Although these effects on infant language had worn off by 24 months, this is a powerful demonstration of the impact that caregiver input can have on language outcomes, and it would be interesting to see if there are comparable effects on infant pragmatic skills.

5.1.2.2 Socioeconomic Status and Caregiver Beliefs. The nature of caregiver input is clearly an important pathway through which SES influences communicative development. One of the ways in which it may exert its influence is by contributing to what a caregiver believes about their role as a parent in the development of their child. We know that parents from lower SES backgrounds tend to have lower parenting self-efficacy (Bradley & Corwyn, 2002; Hoff & Naigles, 2002; Magnuson et al., 2009), they often report feeling that they have less control over their child's developmental outcomes (Elder et al., 1995; Luster & Kain, 1987) and they expect developmental milestones (such as first words) to occur later than higher SES parents do (Hoff et al., 2002). These parental beliefs about their own self-efficacy in shaping their child's learning has potential to shape their behaviour as parents, their socialisation strategies and interaction styles (Coleman & Karraker, 1998; Teti & Gelfand, 1991). Beliefs about parenting also comprise goals related to child development. Parental goals have been shown relate to subsequent parenting behaviours which then have effects on child outcomes (Rowe & Casillas, 2011) and these vary according to SES, for example higher SES parents set higher goals around academic achievement (Bandura et al., 2001).

Beliefs about the degree of influence parents feel they have on their child's learning and growth also differ across domains of development. For example, parents felt they had the primary influence over their child's developing socioemotional skills (such as expressing affection, morals), but not their cognitive skills (such as reasoning and attention), which they felt would be more influenced by the school system and teachers (Knight & Goodnow, 1988). However, very little is known about how parents feel specifically about their role in the teaching or shaping of their child's *pragmatic* skills. In one of the few studies exploring this, Becker and Hall (1989) found that the parents in their sample felt they had primary influence over their child's development of a range of pragmatic skills, from politeness (using greetings, saying please and thank you), to turn taking, staying on topic, and keeping an appropriate tone and volume. However, they did not look for differences between SES groups in this, which given what we know about SES related differences in feelings of self-efficacy would be interesting to account for.

The next sections go onto to consider in turn what we know about the associations between SES and vocabulary, and SES and pragmatic development, highlighting the wealth of work that has established links between the former set, and the dearth of evidence we have about relationships between the latter set. Finally, we consider the relationships between SES and modality (i.e., vocalisations, gestures and gaze), before defining our research questions for the chapter.

5.1.3 The Relationship Between Socioeconomic Status and Vocabulary

Most of the work exploring SES based disparities during development has focused on expressive and receptive vocabulary size and growth. Most pertinent to the current work is the finding that as early as 18 months, infants from lower-SES families had smaller expressive vocabulary than their peers, and the difference between high and low SES infants at this age was equivalent to 6 months (Fernald et al., 2013). These individual differences in vocabulary continue to vary as a function of SES throughout childhood. In their seminal US based study, Hart and Risley (1995) showed that by 3 years, children from high SES households (as indexed by occupation, education, and income) knew twice as many words as those in lower SES households. Despite concerns about their small sample size and methodology (Dudley-Marling & Lucas, 2009; Johnson, 2015; Sperry et al., 2019), social gradients in child vocabulary size have been replicated to varying degrees in the US (Layzer & Price, 2008), the UK (Blanden & Machin, 2010), Australia (Taylor et al., 2013) and Canada (Bradbury et al., 2011). In many of these cases, the disparity constitutes a significant delay in vocabulary growth for low SES children. This delay is particularly pronounced (up to 15 months) for lower SES 5-year-olds in the UK (15 months for expressive vocabulary in the UK Millennium Cohort Study, Blanden & Machin, 2010), and in the US (Taylor et al., 2013).

The significance of these differences is not in the overall number of words by and of itself. Instead, it is what the number is thought to lend to the infants' developing conceptual knowledge and abstract reasoning (Pace et al., 2017), their ability to express and regulate emotions and desires (Roben et al., 2013), and their preparedness to enter a school system which values vocabulary and its use as a tool for pedagogy (Avineri et al., 2015; Heath, 1982; Hoff, 2013; Labov, 1970). However, for others, the equation of formal language ability and cognition and knowledge (Miller & Sperry, 2012) is a misrecognition of a different (not deficient) communication style (Hall, 1976; Rogoff et al., 2017). Furthermore, methods to measure vocabulary differences are often rooted in, and validated according to, mainstream, middle-SES norms that may artificially decrease performance in lower SES children who are simply not used to the structure of standardised tests (Gutierrez-Clellen & Pena, 2001).

The next section goes on to examine findings from the relatively few studies looking at SES and *pragmatic* abilities where the divergence between high and low SES groups is not as straightforward. The picture becomes mixed where attention is turned to communicative outcomes outside of the lexical domain.

5.1.4 Socioeconomic Status and Pragmatics.

Previous studies looking at the relationship between SES and pragmatics in infancy and childhood have mainly focused on four broad categories of pragmatic ability, a) communicative intention, b) joint attention, c) narrative and later emerging skills such as implicature and irony), and we now review these in turn.

5.1.4.1 Communicative Intentions. Recall that communicative intentions or speech acts are the functions and propositional goals behind our utterances, and that infants appear to be able to *use* communication on this functional level (i.e., to get things done), before they have acquired even the first word of their native language (see Chapter 3 section 3.1.1). In this sense, the ability to express and comprehend communicative intentions could be said to be the earliest developing pragmatic ability and fundamental to the development of formal language (Bates, 1976; Bruner, 1981; Ninio & Snow, 1996). Despite this, remarkably few studies have explored the relationship between the expression of communicative intentions in infancy (speech acts) and SES, and those that have, tended to focus on infants who have moved well beyond the stage at which a social gradient first starts to emerge in the infant's vocabulary.

For example, in their functional analysis of the naturalistic language of children at 3 years, Tough (1977) found SES differences in the use of fairly complex, later emerging communicative intentions, with children from lower SES backgrounds less likely to use language for the purpose of reasoning, predicting and imagining. Fannin et al. (2018) adapted Tough's coding scheme to conduct a similar analysis in a larger cohort of 4 year olds (N = 95), ensuring their sample was racially and ethnically diverse, as well as socioeconomically diverse. They coded child language from videos of structured and unstructured interaction with their caregiver according to the following categories of communicative intention, with the later emerging intentions presumed to be evidence of a more pragmatically sophisticated ability to understand others as intentional.

1) Earlier emerging intentions.

i) responding (broadly cognate with answering, acknowledging, and imitating)

ii) self-maintaining (language to mark emotions, criticising, collaborating)

iii) directing (guiding own or others' actions, broadly cognate with requesting)

iv) reporting (labelling, providing details of activities, objects, broadly cognate with commenting).

2) Later emerging intentions.

i) reasoning (justifications, cause and effect, comparisons, identifying problems)

ii) predicting (language to anticipate, future actions)

iii) projecting (how others feels)

iv) imagining (language for pretending)

They found that infants across all groups used all communicative intention types at similar rates despite differences in cultural backgrounds and socioeconomic status. However, lower SES groups produced fewer utterances *overall*, and used language less for reasoning (partially replicating the findings of Tough (1977)). Using language to reason typically includes expressing cause and effect relationships (e.g., 'if you push this, this will fall down'), justifying actions (e.g., 'I did this because…'), making comparisons (e.g., 'this is the same as that') and identifying problems (e.g., 'it won't fit, it's too big'). The authors measured SES by transforming household income into a categorical variable with a binary high SES and low SES group, the cut-off point being set by the US federal poverty guidelines. Therefore, other indices were not considered, including the one thought to be most robustly related to developmental outcomes, caregiver education (Hoff & Naigles, 2002; Magnuson et al., 2009). Nevertheless, the authors found their work consistent with other findings, such as Damico and Damico (1993), and Hammer and Weiss (1999) where SES co-varied only minimally with differences in the use of communicative functions in infants.

5.1.4.2 Social Communication and Joint Attention. Infants are thought to arrive at being able to use communicative intentions like the above by reaching a milestone in their socio-cognitive development around 9 months that allows them to engage in episodes of triadic joint attention (Carpenter & Liebal, 2011; Tomasello, 2010). Triadic joint attention involves the infant and their caregiver mutually sharing attention to the same thing and once established, it provides a framework for the infant to effectively communicate their intentions and understand the intentions of others. A small number of studies have explored SES differences in infants' ability to initiate or respond to triadic joint attention, mainly measured by performance on structured task batteries for example, the Early Social Communication Scales (ESCS; Mundy et al., 2003, see Chapter 3, section 3.1.2.1), or the Dimensional Joint Attention Assessment (DJAA; Reilly et al., 2021). For Mundy et al. (2007), the aim of their study of individual differences in performance on the ESCS was not to establish relationships with SES, but rather to examine the dimensional associations and dissociations between proposed facets of joint attention. However, they did report that infants of less educated mothers displayed more advanced skills in responding to joint attention (following a gaze or a point) at 12 and 15 months. They suggested that this may be due to the increased likelihood of mothers with higher levels of education spending more time at work and away from the home. However, over 70% of mothers in their sample had a college degree or above and over 50% were at the graduate/professional level.

Reilly et al (2021) recently expanded on these findings, looking this time for *qualitative* differences in infant ability to respond to joint attention using the DJAA. They found that that higher SES infants in their sample (between 8 and 18 months, with SES indexed by education and income) were more likely to respond to more sophisticated and less redundant joint attentional cues (compare the saliency of a) a simple head turn, to b) a coordinated head turn with gaze, a vocalisation, and a point), than lower SES children who tended not to differentiate between the types. Abels and Hutman (2015) had reported similar results at 12 months using the ESCS with lower SES children responding more overall to points and gazes, but they also found that higher SES children initiated joint attention more by using actions. This they felt may reflect different learned interaction styles and parental socialisation goals of independence/agency (corresponding to an enhanced ability to initiate to joint attention), and interdependence/compliance (corresponding to an enhanced ability to respond to joint attention) (Keller, 2013; Kohn, 1963). In their naturalistic study of how infants and caregivers structured their interaction during play, Hammer and Weiss (1999) found that infants from lower SES families at 16 months were less likely to use communication to initiate play than their higher SES peers, although they did not look at the use of various types of intention types beyond this.

5.1.4.3 Narrative and Later Emerging Skills. Narrative, essentially extended discourse or storytelling, is thought to be highly pragmatic in nature due to the many choices that the narrator has to make based on context (i.e. what to make explicit and what to assume is mutually known, optimal ordering of events) (Carmiol & Sparks, 2014). Although it is a later emerging skill, it is noteworthy because its association with SES is unclear and dependent on methodology used. For example, Peterson (1994) found that children of four years of age from lower SES backgrounds produced narratives that were minimal and lacked logical and chronological structure compared with higher SES peers. However, such findings are problematic because a) methodologically, narratives were elicited from the children by a researcher according to prompts, and b) narrative competence is evaluated according to expectations of the mainstream school system and therefore do not account for variation in narrative traditions across the SES spectrum (Genishi & Dyson, 2015; Michaels, 1991; Miller & Sperry, 2012), traditions that are particularly rich in low SES communities (Miller & Sperry, 2012). When naturalistic methods are used, findings indicate that lower SES children are twice as likely as higher SES children to engage in co-narration in the home, showing no variation in ability to temporally structure the narrative (Burger & Miller, 1999) or in narrative quality generally (Gardner-Neblett et al., 2012).

It is also worth noting that SES is rarely factored in to work on richer pragmatic skills that emerge later in childhood, possibly down to the majority being in the experimental tradition which seeks to minimize individual differences and establish universals over capturing variation (see Chapter 3, section 3.1.2 and Chapter 4, section 4.1 for further discussions on this). However, the few studies to include SES factors (interestingly all indexed by caregiver education) have mixed results. Small SES effects have been demonstrated on children’s production and comprehension of irony and deceit (Bosco et al., 2013), but no effects on communication failure (Bosco & Gabbatore, 2017), or scalar implicature (Antoniou & Katsos, 2017). More recently, Schulze and Saalbach (2021) found that from four years of age, it was the amount of socio-cognitive engagement (amount of time spent in joint activities between the dyad, i.e. book reading, games, drawing) and not SES that predicted performance on tasks tapping the understanding of indirect communication (e.g. compare the directly interpretable “I want cornflakes” with the indirect “I have a bowl” in the context of sitting at the kitchen table at breakfast time).

In sum, what prior work exploring SES and pragmatics in childhood most clearly demonstrates is the importance of selecting methodologies that are appropriate across the

SES spectrum. Earlier in infancy, we see minimal variation according to SES factors when communication is analysed naturalistically. However, we do see SES effects in performance on structured tasks such as the ESCS. This is also evident later in development to some degree, with lower SES children having poorer or equal/better narrative skills according to whether they are tested in school or observed in the home respectively.

5.1.5 Socioeconomic Status and Modality.

We know that early knowledge of words and some pragmatic abilities have been shown to be associated with aspects of SES. Recall from Chapter 3, section 3.1.1.2, infants at 18 months communicate their intentions using vocalisations and gestures, but they are also able to communicate multimodally, integrating vocalisations and gestures, and coordinating these with gaze. It is feasible that how infants communicate intentions using various modalities could show SES effects, but little work has set out to establish these. Notable exceptions are detailed below.

There is evidence that infants from lower SES backgrounds are less vocal generally. In their study looking at how 16-month-old infants and their caregivers structured free play interaction, Hammer and Weiss (1999) found that infants from lower SES backgrounds vocalised half as much as their middle SES peers overall. For the gestural mode, in their study of 50 14-month-olds, Rowe and Goldin-Meadow (2019) found that infants from lower SES backgrounds (indexed by an education and income composite) used fewer gesture types than their higher SES peers, by ‘types’ the authors meant the number of objects the child referred to using gesture (i.e. pointing to a book = book, pointing to a chair = chair). This number of types correlated with parental use of gesture and predicted later vocabulary size (Rowe & Goldin-Meadow, 2009). When it comes to cross-cultural comparison, the evidence is mixed. Some studies show significant *cross-cultural* differences in gesture use in naturalistic observation (Salomo & Liszkowski, 2013), but others find no such significant differences in semi-experimental or semi-structured tasks (Cameron-Faulkner et al., 2021; Liszkowski et al., 2012). The differences in methodologies could again suggest a difference between what infants can do, and what they *do* do in everyday interactions that is culturally defined and it would be interesting to see if we find a social gradient in our sample.

Gestures and vocalisations become integrated over time and are a particularly salient communicative cue (Martinsen & Smith, 1989). Infants appear to use these more in a) scenarios where they wish to obtain something (Messinger & Fogel, 1998; we replicated this finding in Chapter 3), or b) when they wish to repair communication that has broken down (Igualada et al., 2015; Liszkowski et al., 2008). It could be that infants gradually come to understand that multimodal communication is a particularly effective communicative strategy to 'get things done'. Indeed, it has been shown that caregivers react more to combinations than to solo vocalisations and gestures (Fasolo & D'Odorico, 2012; Murillo & Belinchón, 2012). We know that individual differences in the production of vocal-gesture combinations at 12 months predict lexical and grammatical skills at 18 months (Igualada et al., 2015) and predict the infants' first two-word combination (Fasolo & D'Odorico, 2012; Iverson & Goldin-Meadow, 2005). However, to the best of our knowledge, environmental influences on these individual differences have not been explored.

We know more about *cross-cultural* differences in the coordination of gaze with communicative acts (Akhtar & Gernsbacher, 2008). A gaze to the caregiver is thought to establish a clear communicative channel that helps the infant to observe paralinguistic cues (Csibra, 2010; Farroni et al., 2002), and it is commonly heralded as *the* behavioural marker of communicative intention in naturalistic and experimental work (Bates et al., 1975; Bruner, 1981; Franco & Butterworth, 1996a; Liszkowski et al., 2007; Tomasello et al., 2007). As early as 11 months, infant gaze to caregiver co-occurs with vocalisations and gestures above chance and individual differences in the use of early gaze coordinated vocalisations and gestures predict later language outcomes (Beuker et al., 2013; Donnellan et al., 2020) so it is most likely important for language acquisition generally.

However, some argue that its preeminent status as the necessary signifier of infants' ability to communicate intentionally is not representative of non-WEIRD (not Western, educated, industrialized, rich and democratic) cultures and atypical populations (Akhtar & Gernsbacher, 2008; Henrich et al., 2010). There are marked differences in the coordination of gaze with communicative acts across cultures by both caregiver and infant (Childers et al., 2007; LeVine et al., 1994), and triadic joint attention can occur via alternative modalities such as touch, postural, vocal and auditory cues (Akhtar & Gernsbacher, 2007; T. Field, 2010; Koester et al., 2000). Given that infants' opportunities to access their caregivers' gaze in order to both perceive and signal intention vary across cultures, we may expect variation according to SES measures.

5.1.6 Research Questions

The present Chapter aims to address various gaps and limitations identified in the literature above to test associations between the naturalistic expression of communicative intentions and SES early in infancy at a stage when we know that there is a concurrent significant and robust social gradient in vocabulary size. We do this to address the general and widely acknowledged dearth of studies focusing on environmental influences on all aspects of pragmatic ability (Kidd et al., 2018; O'Neill, 2014; O'Neill, 2007), and also to provide an insight into variation in the use of communicative intentions earlier than the few existing studies have done (Fannin et al., 2018; Tough, 1977). We use naturalistic, observational methods to bypass potential bias against infants from lower SES backgrounds whose performance may be artificially stunted by unfamiliarity with testing scenarios (Adams, 2002; Gutierrez-Clellen & Pena, 2001; Miller & Sperry, 2012). Finally, we choose to consider multiple dimensions of SES (as per Liberatos et al., 1988) since they reflect different forms of capital (economic, human, social), may confer different privileges, and impact differently on various proposed domains (i.e., lexical and pragmatic). We look to see if they interrelate with each other and whether they correlate with caregiver input and beliefs about pragmatics. Since all participants took part in an RCT to evaluate an intervention to promote caregiver contingent talk and infant vocabulary development (see Chapter 2, section 2.1.1, and this Chapter section 5.1.2.4.1), it is important to clarify that focus primarily on findings from the control condition (*n* = 48) since these children's experience was not affected by the intervention, for question 2 and 3 below. However, do we run analysis on the intervention condition group (*n*= 56) to test for differences in patterns of association as set out in question 4 since the RCT found that the intervention was particularly effective for lower SES families (McGillion, et al., 2017). Analyses in Chapters 3 and 4 were not split into control and intervention conditions as these were more straightforward individual difference studies.

To do this, we ask three research questions:

1. Are socioeconomic measures (education, IMD neighbourhood statistics, annual income), correlated with caregiver input and caregiver beliefs about their role in shaping their child's pragmatic development?

2. For the control condition, are SES measures, caregiver input and beliefs correlated with infants' expressive and receptive vocabulary size at 18 months?

3. For the control condition, do these environmental measures correlate with the frequency of infants' naturalistic expression of various communicative intentions at 18 months (i.e., comments, requests, answers, acknowledgements), and their *mode* of expression (i.e., vocalisations, gesture, vocal-gesture, gaze coordination)?

4. Do we find different patterns of association for questions 2) and 3) if we analyse the communicative intentions, formal language and modality use for a subset of infants whose parents took part in an intervention designed to increase their contingent communication?

Firstly, we would expect to see our measures of SES to intercorrelate to some degree, and, for the families who had not participated in a language intervention (henceforth described as the control condition), to see a social gradient in our measure of caregiver input (Hart & Risley, 1995; McGillion et al., 2017), and with our measure of how responsible parents feel in the development of their child's pragmatic skills (Heath, 1982; Hoff et al., 2002). Secondly, we expect to replicate a social gradient in expressive and receptive vocabulary, but again only in the subset of our sample whose parents had not received an intervention at 12 months designed to increase their semantic contingency in interaction (see section 5.2.4). On other studies that have used the Early Social Communication Scale structured tasks (Abels & Hutman, 2015; Mundy et al., 2007; Reilly et al., 2021), we may expect infants from lower SES backgrounds to be use more responsive intention types, and infants from higher SES backgrounds to use more initiative intention types.

As others have noted, it is challenging to hypothesise given the scarcity of extant literature in this area (Fannin et al., 2018). On the experimental results of Fannin et al. (2018) and Tough (1977), we would expect no social gradient in the expression of various communicative intentions, however these studies represented a naturalistic analysis of communicative intention types in the language of children aged 3 or over, and so does not capture the intentions of non-verbal methods of communication. On other studies that have used structured tasks, we may expect infants from lower SES backgrounds to use more responsive intention types, and infants from higher SES backgrounds to use more initiative intention types. Recall that Mundy et al. (2007) and Abels and Hutman (2015) found that infants from lower SES backgrounds showed more advanced gaze following skills at 12 whereas Reilly et al. (2021) found that infants from lower SES backgrounds responded even to redundant or less sophisticated attentional cues (e.g., they still followed a simple head turn which had no accompany communicative behaviours). Infants from higher SES backgrounds on the other hand were more likely to respond only to sophisticated attentional cues (e.g., a head turn with a vocalisation and gesture).

5.2 Methods

5.2.1 Measures of Naturalistic Communicative Intention and Modalities

Chapter 2 presents in detail the methodology for the collection of naturalistic video recordings of dyadic play in our sample of 18-month-old infants (N = 104), and the protocol for coding their frequency of expression of various communicative intentions and modalities.

5.2.2 Environmental Measures

Multiple measures of SES were selected reflecting economic, human and social capital (Duncan & Magnuson, 2003; Rowe, 2008), detailed below:

5.2.2.1 Economic Capital. As part of a demographics questionnaire (see Appendix B), parents were asked to report the household's annual income pre-tax. Questionnaire responses were entered by trained research assistants and assigned a code between 1 – 25, where 1 represented an annual household income of below £3999, and 25 represented an annual household income of £80,000 or above.

5.2.2.2 Human Capital. A combination of indicators and potential mediators of SES that reflect human capital were selected.

5.2.2.1.1. Caregiver Education. The caregiver was asked to define their highest level of education from a list of common UK and European qualifications on the demographics questionnaire (see Appendix B). Each qualification corresponded to a level in the European Qualifications Framework between 1 – 8 (Qualifications and Curriculum, Development Agency, 2010). For example, 1 = below GCSE, 2 = GCSES grades G – D, 3 = GCSES A* -

C, 4 = AS/A-Levels, 5 = Higher National Diploma, 6 = Honours Degree, 7 = Master's Degree, 8 = Doctoral Degree. Questionnaire responses were transformed and entered by trained research assistants and spot checked for accuracy.

5.2.2.1.2 Nature of Caregiver Input. Input was measured using LENA digital language processors (DLP; LENA Research Foundation, 2014). These are lightweight devices worn by infants that record continually (unless paused or stopped) for 16 hours (See Chapter 2 for procedural and researcher home visiting details). Audio data was automatically analysed by LENA software and provided an estimate of the number of words (tokens) spoken by adults in proximity to the infant during the recording. Since it was possible that infants had slept for differing amounts of time, it was decided not to use the overall count from the 16 hours recording. Instead, an average was calculated from caregivers' 8 most vocal hours. When tested on American English, LENA's adult word count (AWC) approximation correlated significantly with human transcriber approximations ($r = .92$, $p < .01$) (Xu et al., 2009). Others have found smaller correlations between automated and manual AWC measures (Oetting et al., 2009; VanDam & Silbert, 2013). Although a slightly crude measure of input, it gives at the least a quantitative indication of the infants' daily experience of language. Nuanced measures that moved beyond word gaps and capture qualitative differences (i.e., McGillion et al., 2017) are undoubtedly more illuminating in unpicking the nature of the influence of input on the infants' development. However, rich, manual coding of caregiver behaviour was unfortunately beyond the scope of this thesis.

5.2.2.1.3 Adult Belief about Pragmatic Skills. We adapted Becker and Hall's (1989) questionnaire (see Appendix B) to capture a sense of parental self-efficacy and responsibility in helping their child to develop skills that are pragmatic in nature (i.e., they take the interlocutor and the context into account). The questionnaire asked parents to rate who they thought was responsible for the transmission of a host of pragmatic skills. The options were either a) themselves as parents b) teachers and school, or c) neither, and the child picks these skills up naturally. The pragmatic skills we asked about were the following.

1. Saying please and thank you

2. Taking turns in conversation

3. Using the right volume

4. Keeping on topic

5. Greeting people, saying hello goodbye

6. Maintaining appropriate eye contact

To arrive at a measure of the caregivers' perceived role in the development of their infants' pragmatic skills, responses were given a score of 1 for every answer of a) themselves as parents and 0 for answers b) or c). Then a total score was calculated so caregivers could score between 0 (no parental responsibility for skills) and 6 (parent is responsible for all skills).

5.2.2.3 Social Capital. Measured by the English Indices of Multiple Deprivation (IMD; Smith et al., 2019). The IMD provides a ranking for every small area (LSOAs; Lower-layer Super Output Areas) in England from 1 (most deprived) to 32,844 (least deprived). IMD scores are calculated according to the data from each small area across several domains (for example, income deprivation, deprivation in access to employment, education, skills and training, to health and disability services, to housing, a safe living environment). Deciles of IMD are derived by splitting the 32,844 small areas into 10 groups ranked from most to least deprived. For our study, participating families were assigned an IMD ranking and then a decile according to the LSOA where their postcode was based.

5.2.3 Measures of Formal Language

Formal language was measured using parental response to the Lincoln UK adaptation of the Bates McArthur Communicative Development Inventory (Infant Form, Meints, 2000). This standardised questionnaire quantifies infants' expressive and receptive vocabulary (see Appendix B). Parents are asked to rate a list of words (presented in categories) as something their infant says (expressive measure), or something their infants understands but doesn't say (receptive measure). Although this is a parental report measure, in Chapter 3 the measure was validated by strong significant correlations with infant word types and tokens as coded manually from the naturalistic video.

5.3 Results

Below, results are reported in turn for each of our four research questions.

5.3.1 Are Socioeconomic Measures, Correlated With Caregiver Input and Caregiver Beliefs About Their Role in Shaping Their Child's Pragmatic Development?

5.3.1.1 Descriptive Summaries. Descriptive statistics for all SES measures are presented in Table 11. There was a range of primary caregiver education levels within the sample, but the majority had a University degree qualification (71%). Participants reported a range of annual household incomes from £4000 - £5999, to £80000 plus, with 37% below UK median annual income (£29900). Within this, 13% listed incomes below the UK poverty line (calculated as incomes 60% below the UK median annual income, £17,940). Families lived across the full range of IMD deciles, with 36% in the most deprived areas (deciles 1-3), 26% in deciles 4-6, and 38% in the least deprived areas (deciles 7-10). Descriptive statistics for caregiver input are also listed in Table 11 as Adult Word Count. There were large individual differences in the overall number of words spoken in the infants' immediate environment (calculated as an average of the caregivers' eight most vocal hours), with some infants hearing five times more words than others. Finally, caregiver responses about their perceived responsibility in teaching their infant a series of pragmatic skills ranged between no responsibility for all skills (2%) to full responsibility for all skills (43%).

Table 11

Descriptive Statistics for Environmental Measures

	N	Minimum	Maximum	Mean	SD	Median
Primary Caregiver Education	103	1	7	5.30	1.64	6.00
Annual Income	102	2	25	14.1	5.12	14.00
IMD	103	1	10	5.28	2.97	6.00
Adult Word Count	85	979.12	4946.50	2611.82	958.86	2508.12
Adult Belief	87	0	6	4.51	1.62	5.00

5.3.1.2 Effects of Condition. Since the infants in our sample had previously taken part in an RCT to test the effectiveness of a parenting intervention designed to increase caregiver’s contingency upon their infants focus of attention in order to mitigate the risk of language delay for socially disadvantaged infants, the remaining analyses used split datasets for those in the intervention and the control condition (the latter group received a dental health intervention instead, see section 5.1.2.3.1 Socioeconomic Status and Caregiver Linguistic Input). The two groups did not differ with respect to the analysed environmental measures (primary caregiver education, U = 1248.5 p = .613; annual income, U = 1281 p = .938; IMD, U = 1223 p = .518; adult word count, U = 776 p = .321; adult belief U = 840.5 p = .375).

5.3.1.3 Correlations between Environmental Measures. Table 12 presents correlations between environmental measures for the control condition. A higher level of caregiver education correlated significantly with a higher annual income and living in a less deprived area, although annual income was not significantly associated with IMD on its own. Adult word count showed weak associations with socioeconomic measures, although not significantly so. Interestingly, our adult belief measure showed significant *negative* correlation with caregiver education. Caregivers reporting higher levels of education reported feeling *less* responsibility for their infants' developing pragmatic skills, instead showing a tendency to select either a 'natural' developmental process or teachers and schooling as responsible. A larger sample size would be needed to test whether this is a statistically significant association.

5.3.2 For the Control Condition, Are SES Measures, Caregiver Input and Beliefs Correlated With Infants' Expressive and Receptive Vocabulary Size at 18 Months?

Table 12 presents correlations between environmental and vocabulary measures for the control condition. All measures of SES, and adult word count correlated significantly and positively with expressive and receptive vocabulary. Adult belief correlated negatively with expressive and receptive vocabulary but not significantly.

Table 12

Correlation Coefficients (Spearman's rho) between Environmental Measures and Vocabulary in the control condition (n = 48)

	1	2	3	4	5	6
Control						
1. Primary Caregiver Education						
2. Annual Income	.528**					
3. IMD	.424**	.577**				
4. Adult Word Count	.238	.241	.190			
5. Adult Belief	-.231	.002	.125	-.222		
6. Expressive vocabulary	.326*	.467**	.404**	.387*	-.068	
7. Receptive vocabulary	.490**	.514**	.352*	.469**	-.289	.646**

*p<0.05, **p<0.01

5.3.3 For the Control Condition, Do Environmental Measures Correlate With the Frequency of Infants' Naturalistic Expression of Various Communicative Intentions at 18 Months (i.e., Comments, Requests, Answers, Acknowledgements), and Their Mode of Expression (i.e., Vocalisations, Gesture, Vocal-Gesture, Gaze Coordination)?

Table 13 presents correlations between environmental measures and naturalistic expression of communicative intentions for the control condition. We saw a weak positive correlation between the overall frequency of communicative acts and measures of SES, which reached significance for the measure of annual income. When looking at each type of communicative act separately, income was significantly correlated with all types of communicative act except comments. Caregiver education was moderately and significantly associated with answers. Adult word count correlated positively and significantly with all communicative intentions except for requests which was a weak non-significant correlation. There was non-significant weak but negative correlation between all communicative intention types and adult belief.

Correlations between environmental measures and mode of expression of communicative intentions in the control condition are displayed in Table 14. We saw weak positive correlations between SES and the use of solo vocalisations, gestures, vocal-gesture combinations and gaze. These reached significance for annual income and IMD, and the frequency of vocal-gesture combinations and coordination of gaze to caregiver. Adult word count associated significantly with all of the modalities except for solo gestures. Adult belief was again negatively but non-significantly correlated with modalities. The relationships between variables presented in Tables 13 and 14 are presented as scatterplots in Appendix D.

Table 13

Correlation Coefficients (Spearman's rho) between Environmental Measures and Naturalistic Expression of Communication Intentions in the Control Condition (n = 48)

	1	2	3	4	5	6	7	8	9	10
Control										
1. Primary Caregiver Education										
2. Annual Income	.528**									
3. IMD	.424**	.577**								
4. Adult Word Count	.238	.241	.190							
5. Adult Belief	-.231	.002	.125	-.222						
6. Overall intentional acts	.234	.289*	.223	.651**	-.102					
7. Comments	.181	.122	.190	.533**	-.062	.786**				
8. Requests	.174	.338*	.214	.268	-.028	.487**	.293*			
9. Answers	.411**	.363*	.173	.352*	-.228	.473**	.246	.024		
10. Acknowledgements	.224	.344*	.149	.349*	-.103	.531**	.258	.129	.463**	

*p<0.05, **p<0.01

Table 14

Correlation Coefficients (Spearman's rho) between Environmental Measures and Modalities in the Control Condition (n = 48)

	1	2	3	4	5	6	7	8	9	10
Control										
1. Primary Caregiver Education										
2. Annual Income	.528**									
3. IMD	.424**	.577**								
4. Adult Word Count	.238	.241	.190							
5. Adult Belief	-.231	.002	.125	-.222						
6. Solo Vocalisations	.217	.120	.121	.578**	-.168					
7. Solo Gestures	.120	.184	.179	.054	-.104	-.062				
8. Vocal-gesture combinations	.228	.339*	.418**	.496**	-.131	.340*	.707**			
9. Gaze coordinated acts	.206	.489**	.298*	.350*	.032	.475**	.301*	.431**		

*p<0.05, **p<0.01

5.3.4 Are There Similar Patterns of Association for the Intervention Condition Group Across Vocabulary, Communicative Intentions and Modalities?

Table 15 presents correlations between the environmental measures in the intervention condition. These were similar (also there was a smaller effect size) than for the control condition whereby caregiver education significantly correlated with income and IMD, but the latter two did not correlate significantly. In this case, adult word count was very weakly or negatively associated with the SES measures, and there was a significant negative association between adult belief and caregiver education.

In the intervention condition, expressive and receptive vocabulary was generally not correlated with the measures of SES, adult word count and adult belief, as presented in Table 15, so we do not see the social gradient as in the control condition. Table 16 presents correlations between the environmental measures and the expression of communicative intentions in the intervention group. Unlike for the control condition, we did not see a pattern of correlations between SES, adult input and adult belief and the various communicative intentions, including the overall number of communicative attempts. Furthermore, as set out in Table 17, there were no significant associations between use of a specific modality, including gaze coordination, and any of the environmental measures apart from adult belief and solo gestures.

Table 15

Correlation Coefficients (Spearman's rho) between Environmental Measures and Vocabulary in intervention condition (n = 56)

	1	2	3	4	5	6
Intervention						
1. Primary Caregiver Education						
2. Annual Income	.309*					
3. IMD	.354**	.200				
4. Adult Word Count	.149	-.022	-.170			
5. Adult Belief	-.333*	-.021	-0.46	.025		
6. Expressive vocabulary	-.087	-.232	-.078	.108	-.090	
7. Receptive vocabulary	-.211	-.299*	-.170	.367*	.237	.600*

Table 16

Correlation Coefficients (Spearman's rho) between Environmental Measures and Naturalistic Expression of Communication Intentions in the Intervention Condition (n = 56)

	1	2	3	4	5	6	7	8	9	10
Intervention										
1. Primary Caregiver Education										
2. Annual Income	.309*									
3. IMD	.354**	.200								
4. Adult Word Count	.149	-.022	-.170							
5. Adult Belief	-.333*	-.021	-0.46	.025						
6. Overall intentional acts	.065	-.069	.029	.115	-.039					
7. Comments	.083	-.080	.042	.200	-.091	.768**				
8. Requests	.096	.005	-.017	.124	.138	.548**	.311*			
9. Answers	.024	-.084	-.022	.008	.071	.804**	.437**	.429**		
10. Acknowledgements	.167	.076	.032	.133	.137	.673**	.397**	.209	.642**	

*p<0.05, **p<0.01

Table 17

Correlation Coefficients (Spearman's rho) between Environmental Measures and Modalities in the Intervention Condition (n = 56)

	1	2	3	4	5	6	7	8	9	10
Intervention										
1. Primary Caregiver Education										
2. Annual Income	.309*									
3. IMD	.354**	.200								
4. Adult Word Count	.149	-.022	-.170							
5. Adult Belief	-.333*	-.021	-0.46	.025						
6. Solo Vocalisations	.186	-.001	-.105	.160	-.080					
7. Solo Gestures	-.103	-.162	.048	-.072	.295*	.095				
8. Vocal-gesture combinations	.037	-.091	.021	.135	.168	.425**	.639**			
9. Gaze coordinated acts	.026	-.105	.026	.102	-.005	.596**	.363**	.632**		

*p<0.05, **p<0.01

5.4 Discussion

In sum, we observed that, for those who had not taken part in an intervention designed to increase caregiver contingency, infants from higher SES families a) had larger expressive and receptive vocabularies, b) produced more vocal-gesture combinations, c) produced more gaze coordinated behaviours, and d) more frequently expressed a range of communicative intentions, suggesting that environmental influences operate on a *functional* as well as lexical level. The results are consistent with previous findings on SES and vocabulary at 18 months (Fernald et al., 2013), but provide new evidence about early differences in the expression of various communicative intentions collapsed across all modalities (vocalisations, gestures and vocal-gestures). Since these effects did not hold in the intervention condition, it appears that encouraging caregivers to talk to their infants about what they were interested in (promoting quality of linguistic interaction) may have a neutralising effect not only on social disparities in vocabulary size, but also in the motivation to use a range of communicative intention across all modalities. We discuss these results below starting with the results from the *control* condition first (in sections 5.4.1, 5.4.2 and 5.4.3). Then we briefly conclude with results from the intervention condition.

5.4.1 Are Socioeconomic Measures, Correlated With Caregiver Input and Caregiver Beliefs About Their Role in Shaping Their Child's Pragmatic Development?

Consistent with work favouring the aggregation of various indicators of SES, our measures of financial (Annual Income), human (Caregiver Education) and social capital (IMD) intercorrelated significantly to a degree (Bornstein & Bradley, 2003; McGillion, Pine, et al., 2017). Caregivers in our sample with higher levels of education tended to report a higher annual income and live in less deprived areas. However, since the correlations were weak to moderate, we felt they displayed sufficient independence as variables to be able to include separately in subsequent analysis to evaluate potentially independent pathways of influence (as per Liberatos et al., 1988; Thornton et al., 2021).

Using a measure of adult word count automatically generated by LENA Digital Language Processors (DLP; a count of the average words detected during the most vocal 8 hours), we saw a small positive correlation between SES measures and adult word count in the control condition that was not statistically significant (although it might be observed to be with a larger sample size). Our findings are more in line with Sperry et al (2019), recently replicated by a meta-analysis (Dailey & Bergelson, 2021), who argue that the word gap is overstated when the limits of the infants' language environments are expanded to include the speech of multiple caregivers, members of extended family and talk from bystanders. In doing so, they demonstrate no difference in the number of words in the infant's environment across the SES spectrum. Since the LENA DLP captures *all* words in the infant's environment, not just those directly addressed to the infant by the caregiver (Xu et al., 2009), less still those directed in a developmentally appropriate manner, it is not surprising that we see no social gradient as our methods align more with the latter group of studies.

Surprisingly, the caregiver's belief about their own role in teaching pragmatic skill to their infants was significantly but negatively correlated with caregiver education so that caregivers with higher levels of education reported feeling *less* responsibility for the development of their infants' pragmatic skills as compared with those with fewer qualifications. Although lower SES parents frequently report feeling less control over their child's development (Elder et al., 1995), we also know that caregivers from higher SES backgrounds have higher goals for their children in terms of academic achievement (Bandura et al., 2001). It could be then that this distancing of parental responsibility among the higher

SES caregivers, reflects higher expectations of, and trust in, the school system amongst more socially advantaged groups who have had good experiences with education. In depth qualitative studies would be needed to explore this further.

5.4.2 For the Control Condition, Are SES Measures, Caregiver Input and Beliefs Correlated With Infants' Expressive and Receptive Vocabulary Size at 18 Months?

As expected, we observed a social gradient in the group who did not receive the contingency intervention with caregiver education, annual income and IMD correlating significantly with expressive and receptive vocabulary. This is consistent with the work of Fernald et al. (2013) who established similar SES effects in the same age group. Adult word count was significantly associated with infant vocabulary, and there were no significant associations between vocabulary measures and the measure of adult belief about pragmatic skills.

5.4.3 For the Control Condition, Do Environmental Measures Correlate With the Frequency of Infants' Naturalistic Expression of Various Communicative Intentions at 18 Months (i.e., Comments, Requests, Answers, Acknowledgements), and Their Mode of Expression (i.e., Vocalisations, Gesture, Vocal-Gesture, Gaze Coordination)?

Overall, the frequency of expression of all intention types combined was highly correlated with adult word count and correlated to a lesser degree with the measures of SES (r's around 0.2). Likewise adult word count and measures of SES were generally positive correlated with infants' use of vocal-gesture combinations and with gaze-coordination acts, suggesting environmental factors promoted use of these more advanced and effective modes of expression.

The infants of caregivers with higher levels of education and who reported higher annual income produced more answers (responses to a question) during interaction, while annual income alone and acknowledgements (a responsive behaviour indicating understanding, agreement, or compliance) were also related significantly. This could be down to socioeconomically mediated variation in parenting style. For example, studies in the US have found that caregivers from higher SES families tend to be more responsive in their interactions with their infants than lower SES peers (Conger & Donnellan, 2007; Flynn & Masur, 2007; Tamis-LeMonda et al., 2001). They also tend to value the asking of questions as a didactic and pedagogic activity with their infants (Avineri et al., 2015; Heath, 1982), and therefore simply provide more opportunities to respond during interaction. Since our measure of caregiver linguistic input was a broad adult word count, we are unable to provide any data as to whether this is the case. Future studies would need to quantify the number of questions asked by the caregiver in order to fully unpick whether infants in higher SES households are more responsive because they are asked more questions, and not because the communicative give and take between the dyad is more reciprocal generally.

It is noteworthy that our findings are not consistent with those previously showing that infants from lower SES families are more likely to respond to joint attention than their higher SES peers in structured social communication tasks (Abels & Hutman, 2015; Mundy et al., 2007; Reilly et al., 2021). However, these are very different variables, with ours being a measure of the infants' naturalistic tendency to be *communicatively* responsive during play via any modality (i.e. vocal, gestural), and performance on the structured tasks above represent simply a measure of infants' following the gaze or point of a researcher, without any complementary communicative behaviour to mark the response (e.g. compare an infant following a point on a structured task, to an infant following a caregiver's point, the caregiver saying "what's that?" and the infant answering "a dog" and alternating gaze to their caregiver).

Alongside answers and acknowledgements, annual income was the SES measure that was associated with both the overall number of intentional acts produced by the infants, and their frequency of requests (an imperative behaviour designed to obtain something), but interestingly not the number of comments. SES measures are thought to be proxies for various forms of capital that confer various advantages and disadvantages that influence development. For example, here, lower annual income may mean less economic resource to procure cognitively stimulating materials for the infant such as books and toys (Conger et al., 2010). A lack of books and toys could in turn influence the quality of interaction providing fewer novel talking points and chances to respond to and initiate joint attention, and chances for the parent to be contingent upon interesting objects. Low annual income may cause more household stress and chaos (Evans et al., 2010; Johnson et al., 2016) and low mood, placing further constraints on caregiver input. High annual income could indicate that caregivers work and that infants spend time at nursery which has been shown to have a positive effect on language outcomes for some pre-schoolers (Roy et al., 2014).

Our measure of adult word count correlated significantly with all communicative intention types except requests. This could imply that the fewer adult words in the infants' environment, the more infants have to explicitly request objects, action and information. If caregivers are closely monitoring their infants' attention at all times and indicating this by speaking more, the infant is less likely to feel they have to bid for it to request something. However, as before, it is difficult to ascertain the direction of influence here, do infants who hear more intentions, produce more? Or do infants who produce more intentions encourage their caregivers to do so? This would be interesting to unpick in future.

Furthermore, we observed significant correlations between higher income and higher IMD score (an indication of a living in a less deprived area) and infant production of multimodal vocal-gesture combinations and in frequency of coordinating communicative acts with a gaze to caregiver. Firstly, the coordination of multiple modalities to produce vocal-gesture combination is thought to be a sign of the infants' developing ability to integrate communicative cues to make them more salient and effective (Martinsen & Smith, 1989; Messinger & Fogel, 1998). This disparity could represent a lack of familiarity with this strategy for lower SES infants, but it could also indicate less of a motivation to deploy it. Recall that Abels and Hutman (2015) and Hammer and Weiss (1999) found that lower SES infants in their studies showed less initiative than their higher SES peers. This they felt was reflective of an SES mediated difference in parent goals and socialisation strategies with lower SES families valuing compliance and higher SES families valuing agency and assertiveness in communication (Keller, 2013; Kohn, 1963). However, a vocal-gesture is a high impact behaviour initiated in fairly specific contexts and so it could be that the lower SES play settings simply presented less prompts to make these kinds of urgent requests. It would be interesting in future to include specific details of the activity taking place at the time of the infants' communicative acts. Something akin to the discourse level of coding in the Inventory of Communicative Acts-Abridged (INCA-A) could tell us what the dyad were trying to bring about together (i.e., were they negotiating, discussing; Ninio et al., 1994), but this could be complemented by broader details of the activity itself (i.e. book reading, stacking blocks) which will have its own communicative routine.

Our finding that infants in lower SES families gazed less to their caregivers during communication contributes to the argument of Akhtar and Gernsbacher (2008) who highlight that the treatment of gaze in the literature as *the* signal par excellence of infant intention and joint attention ignores a) cross cultural variation and b) alternative ways to signal joint attention such as vocalisation, proximity, touch. In our sample, it could represent the fact that for lower SES infants, the caregivers gaze is less accessible either systematically, or simply in the context of the activity taking place (i.e., sat on a lap reading a book). As our data captures a naturalistic snapshot of everyday interaction, we are not saying that there are socioeconomically mediated differences in the *ability* to use gaze to signal intention, simply in everyday motivation or need to use it.

5.4.3 Are There Similar Patterns of Association for the Intervention Condition Group Across Vocabulary, Communicative Intentions and Modalities?

As expected, we saw no significant social gradient in child expressive language in the group who received the contingency intervention (McGillion, Pine, et al., 2017) although there was a significant negative association with annual income and parent reports of receptive vocabulary. Furthermore, there were *no* correlations between any of the environmental measures and the frequency of expression of the various communicative intentions, and in the modalities infants used to express them, including number of vocal-gestures and gaze. This suggests that an intervention that successfully increases the amount of caregiver speech that is contingent upon their infant's current focus of attention promotes not only the mapping of label to referent as thought, but potentially also a deeper understanding of communication on a functional level. It would be interesting to perform a functional analysis of this contingent speech to see if it included more types of communicative intention (i.e., when the infant is focused on a toy dog, did the caregiver talk about the dog in *functionally* diverse ways, such as commenting “look at the dog” *and* requesting “can you give me the dog?”). Unusually, adult word count and expressive vocabulary were only weakly and non-significantly positively correlated in the intervention condition, compared with a significant moderate positive correlation in the control condition. This smaller effect size may approach significance if we had more participants, but it could also be that the intervention increased the quality of caregiver speech and not the quantity.

Overall, we have demonstrated the social gradient observed in the expressive and receptive vocabulary of infants is also evident on the pragmatic, functional level, with annual income and adult input significantly correlating with the overall number of intentional communicative utterances, as well as most of the communicative intention types. Furthermore, annual income, IMD and adult input were significantly correlated with the use of vocal-gesture combinations and coordinating gaze to caregiver. We saw a different pattern of associations in the intervention condition group, suggesting that an intervention designed to promote caregiver contingency might neutralise these effects.

6. General Discussion

In Chapter 1, we explored how usage-based accounts of communication put pragmatics front and centre of their theories of a) how human communication works in interaction (Austin, 1962; Grice, 1957; Wittgenstein, 1953), b) how communication developed in evolution (Moore, 2017; Scott-Phillips, 2017), and c) how we acquire language in infancy (Bates et al., 1975; Tomasello, 2010). In each of these cases, the pragmatic ability to express and recognise communicative intention is thought to be antecedent to formal language and this is particularly well evidenced in infancy where this ability develops prior to the onset of first words. Indeed, preverbal infants may be thought to be operated purely on a pragmatic level.

Despite its proposed centrality however, we know very little about individual differences in early pragmatic development, particularly when compared with our understanding of the variation in the development of vocabulary (Fernald et al., 2013; Hart & Risley, 1995; Hoff, 2003). This may well be due to the fact that a lot of what we know about pragmatics is gleaned from the findings of experimental paradigms which present universals and minimise individual differences. This thesis therefore aimed to 1) explore individual differences in the expression of communicative intentions in a naturalistic setting, 2) test for associations between the naturalistic expression of communicative intentions and performance on a series of structured tasks tapping pragmatic competence, 3) examine potential environmental influences on variation in the expression of communicative intentions. The current chapter presents a summary of the main findings from each empirical chapter considering the potential theoretical and practical implications, particularly in line with Kidd and colleagues' architectural and environmental imperatives (see Chapter 1, section 1.3). Within these sections, we also describe some of the major limitations of the work and make recommendations for future research in this important area.

6.1 Summary of Main Findings

Chapter 2 set out the methodology for the collection and analysis of a dataset of a sample of 18-month-olds (*N* = 104) from the UK Yorkshire and Midlands region interacting with their caregiver. In Chapter 3, we explored variation in the frequency of expression of a range of communicative intentions (comments, requests, answers and acknowledgements) and found striking individual differences in rates of use. We found significant weak to moderate positive intercorrelations between most of the communicative intention types, suggesting that infants who commented more, also requested more and so on. We also found moderate significant positive correlations between the frequency of the majority of the communicative intention types and expressive and receptive vocabulary, suggesting that the ability to express communicative intentions in early infancy is intertwined with formal language skill. *How* the infants signalled intention (whether through a vocalisation, a gesture, a vocal-gesture combination, and whether their communicative act was coordinated with gaze) also varied and children who tended to use one form type frequently, also tended to use others frequently (except for the frequency of solo vocalisations and solo gestures which were not correlated with each other). We also saw that overall, the tendency to a) coordinate gaze, and b) signal intention via the vocal, gestural or vocal-gestural modality differed according to individual intention type. Unintentional acts were overwhelmingly in the solo vocal modality (with virtually all solo gestures and vocal-gestures attributed an intention) and they were also uncoordinated with gaze to the caregiver in our sample. Finally, requests were nearly twice as likely (40%) to be expressed in the vocal-gesture modality than the next most common vocal-gesture intention type, comments (23%), suggesting the imperative motive motivates coordination of modalities to ensure salience and optimal perlocutionary effect (i.e., effect on the hearer).

In Chapter 4, in order to explore the merits of integrating correlational analyses of naturalistic data with performance on structured tasks, we developed a battery of four specifically pragmatic tasks adapted from existing experimental paradigms that we felt might reveal variation. Two of these, Tasks 2 and 4, were found to be suitable for use in a home setting. Task 2 involved following interlocutor gaze to resolve reference, and Task 4 required the infants to initiate joint attention to overcome a communicative frustration episode in which they had to make an imperative request (for a toy to be released from an opaque tub) to an ignorant partner (who had not seen the toy hidden inside). The ignorant partner pretended to simply admire the pot and did not retrieve the toy, requiring the infant to repair a miscommunication if they were so motivated. We found no clear pattern of association between Task 2 and the naturalistic measures of intention types (although performance correlated negatively with the number of requests produced by the infants in a naturalistic setting). Infants' ability and motivation to request and repair communication in Task 4 was positively correlated with the frequency of comments the infants produced naturalistically (and correlations with naturalistic expression of other intentions were positive, if not significant). Overall, there was a little evidence of all pragmatic measures pointing in the same direction but Task 4 did seem to be a viable proxy for the observation of naturalistic communication which we explore further in the next section.

In Chapter 5, looking to explore the environmental imperative, we tested for patterns of association between the expression of the communicative intentions and measures of the infants' familial socioeconomic circumstances, as well as a quantitative measure of caregiver input (adult word count) and a measure of how responsible they felt for the transmission of specifically pragmatic skills. For children who had not received a language intervention designed to mitigate the risk of delay due to social disadvantage, overall, the frequency of expression of all intention types combined was highly correlated with adult word count, and correlated to a lesser degree with the measures of SES (r's around 0.2). Likewise adult word count and measures of SES were generally positively correlated with infants' use of vocal-gesture combinations and with gaze-coordinated acts, suggesting environmental factors promoted use of these more advanced and effective modes of expression. This pattern of correlations did not hold for a subset of infants whose parents had received an intervention to promote caregiver contingency. This contributes evidence that the social gradient evident in studies of variation in vocabulary development is observed also at the pragmatic level and suggests that it is open to intervention.

6.2 Pragmatics and the Architectural Imperative

Collectively, the findings in Chapters 3 and 4 provide a holistic snapshot of the infant's pragmatic ability at 18 months, a point in development at which there is significant variation in formal language ability (Fernald et al., 2013). We saw striking variation in both naturalistic expression of communicative intentions and modalities, but also in performance on the pragmatic tasks, thus meeting Kidd and colleagues' existence imperative (2018) which argues that for our understanding of communicative development to be accurate and equitable, we must account for variation within our samples.

Findings from Chapters 3 and 4 also contribute to our understanding of the architectural structure of theoretically separate domains of the human communication system within the mind. Taken together, the findings from these chapters appear to align with conceptualisations of pragmatics not as a single underlying construct, but rather as a family of related abilities (Norbury et al., 2004; Wilson & Bishop, 2021). Although the majority of the naturalistic measures of the expression communicative intentions (comments, requests, answers, acknowledgements) were positively and significantly intercorrelated, these then displayed associations with performance on one pragmatic task but not another. Chapter 4 section 4.4 discusses possible interpretation for these in more detail but overarchingly what they show is a divergence possibly bought about by methodology (Tamis-LeMonda et al., 2017), in that the structured tasks represent what infants can do (elicited behaviours that demonstrate underlying pragmatic competence), and the naturalistic expressions represent what infants *do* do (naturally occurring behaviours that represent communicative motivation) in everyday interaction.

Some have used the associations/disassociations they have found in empirical studies on infant social communication to argue for competing models of joint attention (joint attention as the framework that allows for the recognition and expression of communicative intentions). For Tomasello and colleagues, joint attention is supported by a unified social-cognitive model wherein pragmatic behaviours spring from the same pro-social motivation and social-cognitive infrastructure, and this was borne out empirically in correlations between performance on social communication tasks (Carpenter, Nagell, et al., 1998; Tomasello, 1995). However, for Mundy et al., joint attention is a multi-dimensional construct, evidenced by dissociations between performance on tasks that tap initiating joint attention and responding to joint attention, and separate correlation between initiating and responding to behavioural requests (Mundy et al., 2007). The patterns of association between the naturalistic expressions appear to align with Tomasello's social-cognitive model, although the differential patterns of association with the structured tasks might suggest a multiple-process model à la Mundy et al. This demonstrates the value of attempting to integrate correlational and structured task methods in providing a fuller picture that we explored in Chapter 4, section 4.1 (Bates, 1988; Garner et al., 1956; Sternberg & Grigorenko, 2001).

However, it also lends weight to calls to standardise how we measure pragmatic ability since as we highlighted in the discussion sections of Chapters 3 and 4, it is difficult to know whether our measures and the measures of Carpenter et al. and Mundy et al. (and indeed the naturalistic INCA-A coding scheme of Snow et al. for that matter) are comparable. It is widely acknowledged that pragmatic abilities are "notoriously difficult to measure in standardised ways because they a set of contextually dependent human behaviours that occur in dyadic exchanges" (Frazier Norbury & Sparks, 2013, p. 48) and consequently there are myriad naturalistic coding schemes, structured social communication tasks and parental report measures that make it challenging to make meaningful comparisons across studies (Adams, 2002; Cameron-Faulkner, 2014b). However, the fact that we found a parallel between our own naturalistic coding scheme an adaptation of the Communicative Intention Inventory (CII; Coggins & Carpenter, 1981, an inventory with 7 categories), and the findings of Snow et al. when using their 60+ category INCA-A scheme, might suggest the naturalistic findings represent fundamental features of infant communication. The average number of communicative attempts per minutes in our sample of 18-month-olds was 5 (*SD* = 2.53), while Snow et al found similar means and standard deviations slightly earlier at 14 months (*M* = 4.37, *SD* = 2.60), and later at 20 months (*M* = 7.91, *SD* = 2.80), and the sequence of most common acts expressed were strikingly similar in our and Snow and colleagues' samples (roughly declaratives, answering, requests). This is despite the two studies being 25 years apart and based in different areas (UK/US). This could well point toward something of a norm in motivation to be communicative around which individual differences sit and future exploration with other populations would be well motivated. Pragmatics has few well-established measures with norms comparable to Mean Length of Utterance and so exploring whether there are norms for what we would expect in a more representative population (not restricted to first born monolinguals as we were here) in terms of mean communicative attempts, or mean number of declaratives etc., per minute across populations would be valuable and could be taken as a culturally-relative clinical benchmark.

Another possible future direction in order to test for the hypothesised relationships between communicative intentions would be to perform a Confirmatory Factor Analysis (CFA) using multiple models, ranging from a single-factor general model wherein all the intentions load onto one construct, to a 4-factor model wherein the intentions load differentially to declarative, imperative, responsive and unintentional constructs as the Mundy et al. model might predict.

We also saw that the naturalistic expression of communicative intention correlated significantly with concurrent expressive and receptive vocabulary size, lending weight to usage-based accounts who predict close intertwining in early infancy, one that gradually becomes less yoked over time (Morales et al., 2000). However, there were only weak positive correlations with performance on pragmatic tasks that did not approach significance. This could be down to sample size, or it could be a dissociation that again is mediated by context whereby the naturalistic expression of communicative intention is closely connected with formal aspects of language, but not as closely related to the understanding of communicative intention (again echoing Mundy et al), but more work is required to understand this.

On a practical note, the barriers to the recruitment and retention of families from lower SES backgrounds to take part in research are well understood, and many hinge upon practical challenges such as lack of income and transportation and less flexible working and childcare patterns (Spoth & Redmond, 2000). It is therefore more likely that we can recruit more representative samples that are inclusive for families across the SES spectrum if research can be administered in the home, as was the case for this study. However, administering a social communication task battery like the Early Social Communication Scales (Mundy et al, 2003) outside of a laboratory setting would be difficult given the length and elaborate set up. Our pragmatic task 4 (requesting and repairing, see Chapter 4) on the other hand could be a viable alternative that requires minimal equipment and set up and elicits a range of pragmatic behaviour in 10 seconds. Performance on Task 4 also correlated with the naturalistic frequency of expression of comments, the declarative, and arguably the most pragmatically sophisticated intention since its function is to share attention and not obtain something. In this way, Task 4 could well be a potential proxy for the observation of naturalistic communication and a measure of infant readiness and motivation for social communication. Further exploration of this task we feel would be well motivated

6.3 Pragmatics and the Environmental Imperative

In Chapter 5 we replicated the social gradient well evidenced in the development of vocabulary in infancy, showing that environmental influences penetrate beyond form and impact the functional level too. This makes sense when we consider it alongside findings from Chapter 3 that demonstrate correlation between expression of communicative intention and on current vocabulary size (which in turn, we know varies as a function of socioeconomic factors). We also found a social gradient in modality, whereby infants from lower SES backgrounds produced fewer multimodal (vocal-gesture combinations) and gaze coordinated acts in naturalistic play settings. Given that in Chapter 3, we saw that both vocal-gesture combinations and gaze coordinated acts were overwhelmingly seen as intentional, it could follow that infants who produce fewer of these behaviours ‘appear’ less communicative generally, which in turn discourages caregivers from engaging (Albert et al., 2018; Bloom et al., 1993; Henning et al., 2005) and could contribute to slower development of vocabulary and formal language more generally.

Adult input tended to correlate significantly with the infant expression of communicative intention. However, a limitation of this study is that we are unable to ascertain the direction of influence (i.e., are infants communicating more because their caregivers are, or are caregivers communicating more because their infants are?). Furthermore, we were restricted to a coarse measure of input from a LENA recorder, which estimates the sheer amount of adult speech the child was exposed to. It does not provide a transcription of that speech, less still code it for child-directedness or quality of interaction. There would therefore be merit in coding the parental behaviour in our sample and, in line with the shift from focusing on the *quantity* of caregiver input, to the *quality*, we argue that a functional analysis of parent communication would be beneficial (as per Fannin et al., 2018), alongside testing for relations between caregiver vocal-gesture combinations and gaze to their infants.

Surprisingly there are few well established norms for gaze coordinated behaviours despite eye contact being a diagnostic criterion for Autistic Spectrum Disorder (Lord et al., 1999). In fact, the use of gaze in child communication has been shown to differ both in clinical and typical populations (Nadig et al., 2010; Norbury et al., 2009), and varies cross-culturally (Zhang et al., 2006). It is therefore not clear that there is an ‘optimal’ outcome here. Analysis of parent and infant communication with the same scheme and with longer term outcomes would allow us to understand the extent to which infants’ communicative motivations and style comes to reflect that of the micro-culture of their home and how this relates to later outcomes when children arrive at school. Overall, the findings certainly suggest that environmental factors go a long way to explaining the large individual differences seen in early communication. They also confirm the value of contextualising infant communicative ability in ecological models of development (Bronfenbrenner, 1977).

6.4 Conclusion

This thesis presents evidence of substantial individual differences in early pragmatic development. Analysis of naturalistic and task measures suggest there is family of pragmatic abilities and motivations that are related to each other (albeit not highly correlated) and to concurrent vocabulary size. Frequency of expression of communicative acts is remarkably comparable to work conducted in the USA in the 1990s, suggesting something of a stable phenomenon in terms of infants’ motivations to communicate with a range of intentions. We established a social gradient both in the frequency of expression of communicative intentions and in their mode of expression with multimodal and gaze-coordinated behaviours. This gradient appears to be explained in large part by environmental factors. Overall, the present work represents a step towards providing a comparable picture of early variation in *pragmatics* to complement what we know about variation in formal language.

7. References

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8.1 Appendix A: Video & Audio Consent Forms

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Tel: 0114 222 6520

CONSENT FORM

Title of Study: Infant development from 11 to 24 months: A longitudinal training study.

Researchers: Dr. Danielle Matthews, Dr Jane Herbert, Prof Julian Pine, Dr Becca Knowles
Michelle McGillion, Postgraduate Researcher
Anna Ryder, Postgraduate Researcher
Gemma Stephens, Postgraduate Researcher

Please initial box

1. I confirm that I have read and understand the information sheet dated [DATE] for the above study and have had the opportunity to ask questions. [ ]
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. [ ]
3. I agree to take part in the above study. [ ]
4. I agree for my child to take part in the above study. [ ]
5. I agree for the data collected from me and my child to be used in future research

______________________	______________	__________________
Name of Parent	Date	Signature
______________________	______________	__________________
Researcher	Date	Signature

Department of Psychology
Head of Department Professor G. Turpin

Psychology Building
Western Bank
Sheffield
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Tel: 0114 222 6520

CONSENT FORM

Title of Study: Infant development from 11 to 24 months: A longitudinal training study.

Researchers: Dr. Danielle Matthews, Dr Jane Herbert, Prof Julian Pine, Dr Becca Knowles
Michelle McGillion, Postgraduate Researcher
Anna Ryder, Postgraduate Researcher
Gemma Stephens, Postgraduate Researcher

Please initial box

1. I **AGREE** to the automatic analysis of the audio recording collected on [DATE]. [ ]

2. I **DO NOT AGREE** to the automatic analysis of the audio recording collected on [DATE]. [ ]

3. I **AGREE** to researchers listening to and transcribing the audio recording collected on [DATE]. [ ]

4. I **DO NOT AGREE** to researchers listening to and transcribing the audio recording collected on [DATE]. [ ]

Name of Parent	Date	Signature
Researcher	Date	Signature

QUESTIONNAIRE 1 Participant #:

It is important that the children who take part in our studies are representative of the nation as a whole. Please answer <u>all</u> questions as accurately as possible. Please be reassured this information will be stored securely and anonymously and will not be shared with any third parties.

Your Child's Date of Birth: ____/___/____ Your Postcode: __________________________

Date Form Completed:___/___/___ (day/month/year) Form completed by: _____________ (e.g., Mum/Dad/Gran)

Infant Information

Does your child have any brothers or sisters? Yes □ No □

If Yes, please give details ____

Does your child have a hearing impairment OR has s/he had a significant ear infection? Yes □ No □

If Yes, please give details ____

Does your child have any other health problems? Yes □ No □

If Yes, please give details ____

At what age did your child do the following: **(please specify the age in MONTHS)**

Crawled _________________ Walked alone without support __________________

General Information on the Child and Family

Who is the person who normally looks after your child, e.g., Mum, Dad, Grandparent)?

____

(If a the person who normally looks after your child is someone other than their mother, please fill in their details in the Mother's details section below)

Does your child go to nursery? Yes □ No □

If yes, how many hours a week do they go? _______________________________________

Parental information

Mother's Occupation: ____

Father's Occupation: ____

Title of Mothers' highest educational qualification

____

Title of Fathers' highest educational qualification

____

Have you completed any new qualifications in the past 6 months Yes □ No □

If Yes, for each parent, please select one category for each, which best describes their highest level of education:

	Mother	Father		Mother	Father
Entry level Award, Certificate or Diploma	□	□	NVQ (Level 3)	□	□
Entry level Functional Skills	□	□	BTEC Professional Diploma, Certificate or Award	□	□
Entry level Foundation Learning	□	□	HNC	□	□
GCSEs grade D-G	□	□	NVQ (Level 4)	□	□
BTEC Award, Certificate or Diploma (Level 1)	□	□	HND	□	□
Functional Skills (Level 1)	□	□	Foundation Degree	□	□
Foundation Learning Tier pathways	□	□	BTEC Advanced Professional Diploma, Certificate or Award	□	□
NVQ (Level 1)	□	□	Bachelor's degree	□	□
GCSEs grade A*-C	□	□	Bachelor's degree with honours	□	□
BTEC Award, Certificate or Diploma (Level 2)	□	□	Professional Graduate Certificate in Education (PGCE)	□	□
Functional Skills (Level 2)	□	□	NVQ (Level 5)	□	□
NVQ (Level 2)	□	□	Postgraduate certificate	□	□
A levels	□	□	Postgraduate diploma	□	□
International Baccalaureate	□	□	Postgraduate degree	□	□
BTEC Award, Certificate or Diploma (Level 3)	□	□			

Household income

Has your annual household income changed in the past 6 months Yes □ No □

If Yes, please select a category which best describes your **annual Household income before tax**. If you do not know your exact **annual household income before tax**, please select the range of categories in which your annual income falls.

below £3999	□	£4,000 to £5,999	□	£6,000 to £7,999	□	£8,000 to £9,999	□
£10,000 to £11,999	□	£12,000 to £13,999	□	£14,000 to £15,999	□	£16,000 to £17,999	□
£18,000 to £19,999	□	£20,000 to £23,999	□	£24,000 to £27,999	□	£28,000 to £31,999	□
£32,000 to £35,999	□	£36,000 to £39,999	□	£40,000 to £43,999	□	£44,000 to £47,999	□
£48,000 to £51,999	□	£52,000 to £55,999	□	£56,000 to £59,999	□	£60,000 to £63,999	□
£64,000 to £67,999	□	£68,000 to £71,999	□	£72,000 to £75,999	□	£76,000 to £79,999	□
£80,000 or above	□						

Has your weekly household income changed in the past 6 months Yes □ No □

If Yes, please select a category which best describes your **weekly household income after tax, including benefits but after housing costs**. If you do not know your exact **weekly household income after tax, including benefits but after housing costs**, please select the range of categories in which your weekly income falls.

below £49	□	£50 to £99	□	£100 to £149	□	£150 to £199	□
£200 to £249	□	£250 to £299	□	£300 to £349	□	£350 to £399	□
£400 to £449	□	£450 to £499	□	£500 to £549	□	£550 to £599	□
£600 to £649	□	£650 to £699	□	£700 or above	□		

QUESTIONNAIRE 2

Please answer all questions as accurately as possible.

1) **How many of your child's teeth have come through?** __________

2) **How many days a week are his/her teeth brushed?** ________________________

3) **When do you (or someone else) brush your child's teeth?** (Please circle one option)

   A) In the morning

   B) Before bedtime at night

   C) Both in the morning and at night

   D) Other: please give details

____

4) ***Does your child have their own toothbrush?*** YES/NO *(delete one)*

5) ***Do you use toothpaste?*** YES/NO *(delete one)*

   If YES,

   What type of toothpaste do you use? Adult ☐ Infant ☐

   Can you remember which brand? _____________________

   How much toothpaste do you use? (please circle one)

   don't know   a smear   a pea sized amount   more than a pea-sized amount

If possible, please describe how you brush your child's teeth:

6) **How long is spent brushing your child's teeth?** (Please circle one option)

   A) 0-30 seconds

   B) 30 seconds – 1 minute

   C) 1minute – 1 minute 30 seconds

   D) 2 minutes – 2minutes 30 seconds

   E) 2 minutes 30 seconds – 3minutes

   F) more than 3 minutes

7) **Do you have any problems brushing your child's teeth?** **YES/NO** (delete one)

If YES, please give details below:

8) **Have you received information about caring for your child's teeth/dental health?**

YES/NO (delete one)

If YES, please indicate where you received information from (Tick all that apply)

- ☐ Health visitor
- ☐ Childcare professional
- ☐ Practice nurse/doctor
- ☐ Pharmacist
- ☐ Dentist
- ☐ Parent & baby group
- ☐ Friends/family
- ☐ Television/radio programme
- ☐ Magazine/newspaper article
- ☐ Internet (e.g., website, forum, blog)
- ☐ Other, please specify: ___________________________________

If you have received information about caring for your child's teeth from more than one source, did you receive the same advice from all of them? **YES/NO** (delete one)

If NO, please give details

9) **Has your child seen a dentist?** **YES/NO** (delete one)

QUESTIONNAIRE 3

1) At breakfast time, what is your child most likely to eat?

	Never	**Hardly ever**	**Sometimes**	**Quite often**	**Often**
Porridge or cereal with milk	O	O	O	O	O
Cereal without milk	O	O	O	O	O
Whole-wheat toast	O	O	O	O	O
White toast	O	O	O	O	O
Yogurt (plain)	O	O	O	O	O
Yogurt (flavoured)	O	O	O	O	O
Eggs	O	O	O	O	O
Nothing	O	O	O	O	O
Other (please specify)	O	O	O	O	O

2) How often does your child have a snack during the day?

0 1 2 3 4 5 6 7 8 9 10+

3) When your child has a snack, what is it most likely to be?

	Never	**Hardly ever**	**Sometimes**	**Quite often**	**Often**
Biscuits	O	O	O	O	O
Breadsticks	O	O	O	O	O
Cake	O	O	O	O	O
Cheese	O	O	O	O	O
Chocolate	O	O	O	O	O
Chopped raw vegetables	O	O	O	O	O
Crisps	O	O	O	O	O
Dried fruit	O	O	O	O	O
Fresh fruit	O	O	O	O	O
Oat cakes	O	O	O	O	O

	Never	Hardly ever	Sometimes	Quite often	Often
Rice cakes	O	O	O	O	O
Sweets	O	O	O	O	O
Yoghurt (plain)	O	O	O	O	O
Yoghurt (flavoured)	O	O	O	O	O
Other, please specify	O	O	O	O	O

Please give details of your child's favourite snacks:

4) **How often does your child have a drink during the day (including at snack times, mealtimes, and bedtime and at other times)?**

0 1 2 3 4 5 6 7 8 9 10+

5) **What does your child drink at these times?**

Please tick all that apply

	Snack times	Mealtimes	Bedtime	During the night	At other times
Plain milk	O	O	O	O	O
Breast milk	O	O	O	O	O
Flavoured milk	O	O	O	O	O
Water	O	O	O	O	O
Fruit juice (pure)	O	O	O	O	O
Fruit juice (diluted)	O	O	O	O	O
Fizzy drinks	O	O	O	O	O
Fizzy drinks (diet)	O	O	O	O	O
Hot drinks (e.g., tea, hot chocolate)	O	O	O	O	O
Nothing	O	O	O	O	O
Other, please specify	O	O	O	O	O

Do you add sugar to any of your child's drinks? **YES/NO** *(delete one)*

If YES, please specify: ____

____

6) What does your child usually drink from?

	Bottle	Sippy cup/ lidded beaker	Open cup or beaker	Breast	Not applicable
Snack times	O	O	O	O	O
Meal times	O	O	O	O	O
Bed time	O	O	O	O	O
During the night	O	O	O	O	O
At other times	O	O	O	O	O

7) How many portions of fruit or vegetables does your child eat each day?

0 1 2 3 4 5 6+

***8)* Does your child have a fixed sleeping routine? YES/NO** *(delete one)*

Please give details (e.g. regularity and length of day time naps and nighttimes sleep)

***9)* Does your child sleep through the night? YES/NO** *(delete one)*

If YES, please specify**,** when did your child start doing so: ______________________

10) How many hours sleep does your child have each night? (Please circle one option)

< 9 hours 9hours 10hours 11hours 12hours >12 hours

QUESTIONNAIRE 4

Part I: Early Words

A. First signs of understanding

Before a child begins to speak, they show signs of understanding language by responding to familiar words and phrases. Below are some common examples. Does your child do any of these?

		yes	no
1.	Respond when name is called (e.g. by turning around and looking at source)	O	O
2.	Respond to “no no” (by stopping what he/she is doing, at least for a moment)	O	O
3.	React to “there’s mummy/daddy” by looking around for them	O	O

B. Phrases

In the list below, please mark the phrases that your child seems to understand

	understands		understands		understands		understands
Are you hungry?	O	Daddy’s/mummy’s home	O	Give me a kiss	O	Sit down	O
Are you tired/sleepy?	O	Do you want more?	O	Go get ___	O	Spit it out	O
Be careful	O	Don’t do that	O	Good girl/boy	O	Stop it	O
Be quiet	O	Don’t touch	O	Hold still	O	Time to go night night	O
Clap your hands	O	Get up	O	Let’s go bye bye	O	Throw the ball	O
Change nappy	O	Give it to mummy	O	Look/Look here	O	This little piggy	O
Come here/come on	O	Give me a hug	O	Open your mouth	O	Want to go for a ride	O

C. Starting to talk

1. What were your child’s first three words? (leave blank if you can’t remember)

1. **2.** **3.**

2. Some children like to “parrot” or imitate things that they’ve just heard (including new words that they are just learning, and/or parts of sentences, for example, repeating “work now” after mother says “ Mummy’s going to work now.”) How often does your child imitate words?

Never O Sometimes O Often O

3. Some children like to go around naming of labelling things, as though proud of knowing the names and wanting to show this. How often does your child do this?

Never O Sometimes O Often O

For the items below, please mark the box that **best applies** to your child **at this time:**

		NEVER	**RARELY**	**SOMETIMES**	**OFTEN**
4.	It is fairly easy for me to teach my child a new word	O	O	O	O
5.	It is fairly easy for me to know when my child and I are both talking about the same thing	O	O	O	O

D. Vocabulary checklist

The following is a list of typical words in young children's vocabularies.

For words you child understands but does not yet say, place a mark in the first column, labelled "U" (understands). For words that your child understands and also says, place a mark in the second column, labelled "U/S" (understands and says). If your child uses a different pronunciation of a word (e.g., 'bickie' for biscuit, or 'telly' for television), mark the word anyway. Occasionally we list two alternative forms e.g. pool/pond - please underline the one your child understands and/or produces.

Remember this is a catalogue of words that are used by many children across a wide age range, so do not worry if your child knows only a few of them at the moment!

If you have any additional comments or information that you think we should consider, please add these at the end of this checklist.

Sounds	**U**	**U/S**		**U**	**U/S**
baa baa	O	O	ouch	O	O
choo choo	O	O	quack	O	O
cockadoodledoo	O	O	uh oh	O	O
grr	O	O	vroom	O	O
meow	O	O	woof	O	O
moo	O	O	yum	O	O

Animals	**U**	**U/S**		**U**	**U/S**
animal	O	O	horse	O	O
bear	O	O	kitten	O	O
bee	O	O	lamb	O	O
bird	O	O	lion	O	O
bunny / rabbit	O	O	monkey	O	O
butterfly	O	O	mouse	O	O
cat	O	O	owl	O	O
chicken	O	O	penguin	O	O
cow	O	O	pig	O	O
deer	O	O	pony	O	O
dog	O	O	puppy	O	O
donkey	O	O	sheep	O	O
duck	O	O	spider	O	O
elephant	O	O	squirrel	O	O
fish	O	O	tiger	O	O
frog	O	O	turkey	O	O
giraffe	O	O	turtle	O	O
goose	O	O			

Vehicles	**U**	**U/S**		**U**	**U/S**
aeroplane/plane	O	O	bus	O	O
bicycle / bike	O	O	car	O	O
boat	O	O	fire engine	O	O
lorry / truck	O	O	pushchair	O	O
motor-bike	O	O	train	O	O

Toys	**U**	**U/S**		**U**	**U/S**
ball	O	O	doll	O	O
balloon	O	O	pen	O	O
block / brick	O	O	teddy bear	O	O
book	O	O	toy	O	O
bubble	O	O			

Food and Drink	**U**	**U/S**		**U**	**U/S**
apple	O	O	food	O	O
banana	O	O	ice cream	O	O
biscuit	O	O	jam	O	O

bread	O	O	juice	O	O
butter	O	O	meat	O	O
cake	O	O	milk	O	O
carrot	O	O	orange	O	O
cereal	O	O	pasta /spaghetti	O	O
cheese	O	O	peas	O	O
chicken	O	O	pizza	O	O
chips	O	O	sweets	O	O
coffee	O	O	tea	O	O
drink	O	O	toast	O	O
egg	O	O	water	O	O
fish	O	O			

Body Parts	**U**	**U/S**		**U**	**U/S**
arm	O	O	hair	O	O
belly button / tummy button	O	O	hand	O	O
cheek	O	O	head	O	O
ear	O	O	knee	O	O
eye	O	O	leg	O	O
face	O	O	nail	O	O
finger	O	O	nose	O	O
foot	O	O	toe	O	O
tongue	O	O	tummy	O	O
tooth	O	O	mouth	O	O

Clothes	**U**	**U/S**		**U**	**U/S**
bib	O	O	dress	O	O
boot(s)	O	O	glasses / specs	O	O
button	O	O	hat	O	O
coat	O	O	jacket	O	O
jeans	O	O	shoe	O	O
jumper / sweater	O	O	shorts	O	O
nappy	O	O	sock	O	O
necklace	O	O	trousers	O	O
pyjamas	O	O	zip	O	O
shirt	O	O			

Furniture and Rooms	**U**	**U/S**		**U**	**U/S**
bath / bathtub	O	O	living room	O	O
bathroom	O	O	play pen	O	O
bed	O	O	potty	O	O
bedroom	O	O	refrigerator/ fridge	O	O
chair	O	O	rocking chair	O	O
cooker / stove / oven	O	O	settee / sofa	O	O
cot	O	O	sink	O	O
door	O	O	stairs	O	O
drawer	O	O	table	O	O
garage	O	O	TV / television	O	O
high chair	O	O	window	O	O
kitchen	O	O			

Outside	**U**	**U/S**		**U**	**U/S**
beach	O	O	outside	O	O
bucket	O	O	park	O	O
church	O	O	party	O	O
flower	O	O	pool	O	O
garden	O	O	rain	O	O
house	O	O	school	O	O
moon	O	O	shop	O	O
sky	O	O	swing	O	O
slide	O	O	tree	O	O

snow	O	O	wall	O	O
spade	O	O	water	O	O
star	O	O	work	O	O
stone	O	O	zoo	O	O
sun	O	O			

Household items	**U**	**U/S**		**U**	**U/S**
bin	O	O	bowl	O	O
blanket	O	O	box	O	O
bottle	O	O	broom	O	O
brush	O	O	paper	O	O
clock	O	O	penny	O	O
comb	O	O	picture	O	O
cup	O	O	pillow	O	O
dish	O	O	plant	O	O
dummy	O	O	plate	O	O
fork	O	O	purse	O	O
glass	O	O	radio	O	O
hammer	O	O	rubbish	O	O
hoover / vacuum	O	O	scissors	O	O
jug	O	O	soap	O	O
key	O	O	spoon	O	O
lamp	O	O	telephone	O	O
light	O	O	toothbrush	O	O
medicine	O	O	towel	O	O
money	O	O	watch	O	O
mug	O	O			

People	**U**	**U/S**		**U**	**U/S**
aunt	O	O	girl	O	O
baby	O	O	grandma	O	O
boy	O	O	grandpa	O	O
brother	O	O	lady	O	O
child	O	O	man	O	O
daddy	O	O	mummy	O	O
doctor	O	O	nanny	O	O
friend	O	O	people	O	O
person	O	O	teacher	O	O
policeman	O	O	uncle	O	O
sister	O	O			

Games and Routines	**U**	**U/S**		**U**	**U/S**
bath	O	O	no	O	O
breakfast	O	O	pat-a-cake	O	O
bye bye	O	O	peekaboo	O	O
dinner	O	O	please	O	O
don't	O	O	shh/hush/shush	O	O
hello	O	O	tea	O	O
hi	O	O	thank you	O	O
lunch	O	O	wait	O	O
nap	O	O	want to	O	O
night night	O	O	yes	O	O

Action Words	**U**	**U/S**		**U**	**U/S**
bite	O	O	know	O	O
blow	O	O	like	O	O
break	O	O	look	O	O
bring	O	O	love	O	O
bump	O	O	make	O	O
call	O	O	open	O	O
carry	O	O	play	O	O

catch	O	O	pull	O	O
clean	O	O	push	O	O
cry	O	O	put	O	O
cuddle	O	O	read	O	O
cut	O	O	ride	O	O
dance	O	O	run	O	O
draw	O	O	say	O	O
drink	O	O	scratch	O	O
drive	O	O	see	O	O
drop	O	O	show	O	O
eat	O	O	shut / close	O	O
fall	O	O	sing	O	O
feed	O	O	sleep	O	O
find	O	O	smile	O	O
finish	O	O	splash	O	O
get	O	O	stop	O	O
give	O	O	swim	O	O
go	O	O	swing	O	O
have	O	O	take	O	O
hear	O	O	tell	O	O
help	O	O	throw	O	O
hit	O	O	tickle	O	O
hug	O	O	walk	O	O
hurry	O	O	wash	O	O
jump	O	O	watch	O	O
kick	O	O	wipe	O	O
kiss	O	O	write	O	O

Descriptive Words	**U**	**U/S**		**U**	**U/S**
all gone	O	O	clean	O	O
asleep	O	O	cold	O	O
bad	O	O	dark	O	O
big	O	O	dirty	O	O
blue	O	O	dry	O	O
broken	O	O	empty	O	O
careful	O	O	fast	O	O
fine	O	O	old	O	O
gentle	O	O	pretty	O	O
good	O	O	red	O	O
green	O	O	sad	O	O
happy	O	O	scared	O	O
hard	O	O	sick	O	O
hot	O	O	sleepy	O	O
hungry	O	O	soft	O	O
hurt	O	O	thirsty	O	O
little	O	O	tired	O	O
nasty	O	O	wet	O	O
naughty	O	O	yellow	O	O
nice	O	O			

Question words	**U**	**U/S**		**U**	**U/S**
how	O	O	where	O	O
what	O	O	who	O	O
when	O	O	why	O	O

Time	**U**	**U/S**		**U**	**U/S**
day	O	O	now	O	O
later	O	O	today	O	O
morning	O	O	tomorrow	O	O
night	O	O	tonight	O	O

Pronouns	**U**	**U/S**		**U**	**U/S**
her	O	O	my	O	O
his	O	O	that	O	O
I	O	O	this	O	O
it	O	O	you	O	O
me	O	O	your	O	O
mine	O	O			

Prepositions	**U**	**U/S**		**U**	**U/S**
away	O	O	on	O	O
back	O	O	out	O	O
down	O	O	there	O	O
in	O	O	under	O	O
inside	O	O	up	O	O
off	O	O			

Quantifiers	**U**	**U/S**	**U**	**U/S**	
all	O	O	not	O	O
again	O	O	other	O	O
another	O	O	same	O	O
more	O	O	some	O	O
none	O	O			
Extra words	**U**	**U/S**		**U**	**U/S**
chase (action)	O	O		O	O
smell (action)	O	O		O	O
	O	O		O	O
	O	O		O	O
	O	O		O	O
	O	O		O	O

If you have any further comments, please write them below.

E. Your child's requests for help

For the item below, please mark the box that **best applies** to your child **at this time:**

	NEVER	RARELY	SOMETIMES	OFTEN
1. my child uses his/her words to ask for my help	O	O	O	O

Does your child ask for your help:

	YES	NO
1. by using the word "help"	O	O
2. by telling you what he/she wants by name (e.g., milk, cookie)	O	O
3. by asking you to do something again (e.g., More.; Do it again)	O	O
4. to play a game	O	O
5. by asking you to do something difficult (e.g., to open a door, to carry something heavy)	O	O
6. by asking you to make a toy work, or fix a toy	O	O

Part II: Actions and Gestures

A. First Communicative Gestures

When infants are first learning to communicate, they often use gestures to make their wishes known. For each item below, mark the line that describes your child's actions right now.

	Not Yet	Sometimes	Often
1. Extends arm to show you something he/she is holding.	O	O	O
2. Reaches out and gives you a toy or some object that he/she is holding.	O	O	O
3. Points (with arm and index finger extended) at some interesting object or event.	O	O	O
4. Waves bye-bye on his or her own when someone leaves.	O	O	O
5. Extends his/her arm upward to signal a wish to be picked up.	O	O	O
6. Shakes head "no".	O	O	O
7. Nods head "yes".	O	O	O
8. Gestures "hush" by placing finger to lips	O	O	O
9. Requests something by extending arm and opening and closing hand.	O	O	O
10. Blows kisses from a distance.	O	O	O
11. Smacks lips in a "yum yum" gesture to indicate that something tastes good.	O	O	O
12. Shrugs to indicate "all gone" or "where'd it go".	O	O	O

At this time, does your child use any of the following **gestures** to **ask you for something**, with or without words? If your child is not using a gesture described below anymore, but did use the gesture in the past, mark the box "not anymore."

	NEVER	RARELY	SOMETIMES	OFTEN	NOT ANYMORE
12. take your hand, push it, or lead you, to what he/she wants	O	O	O	O	O
13. put a toy or book in your lap, or climb into your lap with a toy	O	O	O	O	O
14. lift his/her arms to ask to be carried	O	O	O	O	O
15. hold up an object to show what he /she wants (e.g., hold up a cup to ask for milk)	O	O	O	O	O
16. reach for or point at what he/she wants	O	O	O	O	O
17. get in a starting position so you will play a game again (e.g., hold his/her feet up so that you will tickle them again)	O	O	O	O	O
18. look where something is that he/she wants you to get	O	O	O	O	O
19. look at something that he/she wants you to do something with	O	O	O	O	O
20. look at you when he/she wants information from you	O	O	O	O	O

For each item below, please mark the box that **best applies** to your child **at this time:**

	NEVER	RARELY	SOMETIMES	OFTEN	NOT ANYMORE
21. my child tries to get my help using gestures	O	O	O	O	O
22. my child uses gestures to get me to play with him/her	O	O	O	O	O

If your child finds something that **interests** him/her, would he/she use any of the following gestures, with or without words?

	YES	NO
23. **point** at what he/she finds interesting	O	O
24. **bring** to you, **show** to you, or **give** to you something he/she finds interesting	O	O

B. Games and Routines

Does your child do any of the following?

	Yes	No
1. Play peekaboo.	O	O
2. Play pattycake.	O	O
3. Play "so big".	O	O
4. Play chasing games.	O	O
5. Sing.	O	O
6. Dance.	O	O

C. Actions with Objects

Does your child do <u>or try to do</u> any of the following?

	Yes	No
1. Eat with a spoon or fork.	O	O
2. Drink from a cup containing liquid.	O	O
3. Comb or brush own hair.	O	O
4. Brush teeth.	O	O
5. Wipe face or hands with a towel or cloth.	O	O
6. Put on hat.	O	O
7. Put on a shoe or sock.	O	O
8. Put on a necklace, bracelet or watch.	O	O
9. Lay head on hands and squeeze eyes shut as if sleeping.	O	O
10. Blow to indicate something is hot.	O	O
11. Hold plane and make it "fly".	O	O
12. Put telephone to ear.	O	O
13. Sniff flowers.	O	O
14. Push toy car or truck.	O	O
15. Throw a ball.	O	O

		Yes	No
16.	Pour pretend liquid from one container to another.	O	O
17.	Stir pretend liquid in a cup or pan with a spoon.	O	O

D. Pretending to be a Parent

Here are some things that young children sometimes do with stuffed animals or dolls. Please mark the actions that you have seen your child do.

		Yes	No
1.	Put to bed.	O	O
2.	Cover with a blanket.	O	O
3.	Feed with bottle.	O	O
4.	Feed with spoon.	O	O
5.	Brush/comb its hair.	O	O
6.	Pat or burp it.	O	O
7.	Push in a buggy.	O	O
8.	Rock it.	O	O
9.	Kiss or hug it.	O	O
10.	Try to out a shoe or sock or hat on it.	O	O
11.	Wipe its face and hands.	O	O
12.	Talk to it.	O	O
13.	Try to put a diaper on it.	O	O

F. Imitating Other Adult Actions
(Using real or toy implements)

Does your child do or try to do any of the following?

		Yes	No
1.	Sweep with a broom or mop.	O	O
2.	Put key in door or lock.	O	O
3.	Pound with a hammer or mallet.	O	O
4.	Attempt to use a saw.	O	O
5.	“Type” at a typewriter or computer keyboard.	O	O
6.	“Read” (opens book, turns page).	O	O
7.	Vacuum.	O	O
8.	Water plants.	O	O
9.	Play musical instrument (e.g., piano, trumpet).	O	O
10.	“Drive” car by turning steering wheel.	O	O
11.	Wash dishes.	O	O
12.	Clean with cloth or duster.	O	O
13.	Write with a pen, pencil or marker.	O	O
14.	Dig with a shovel.	O	O

15. Put on glasses.	O	O

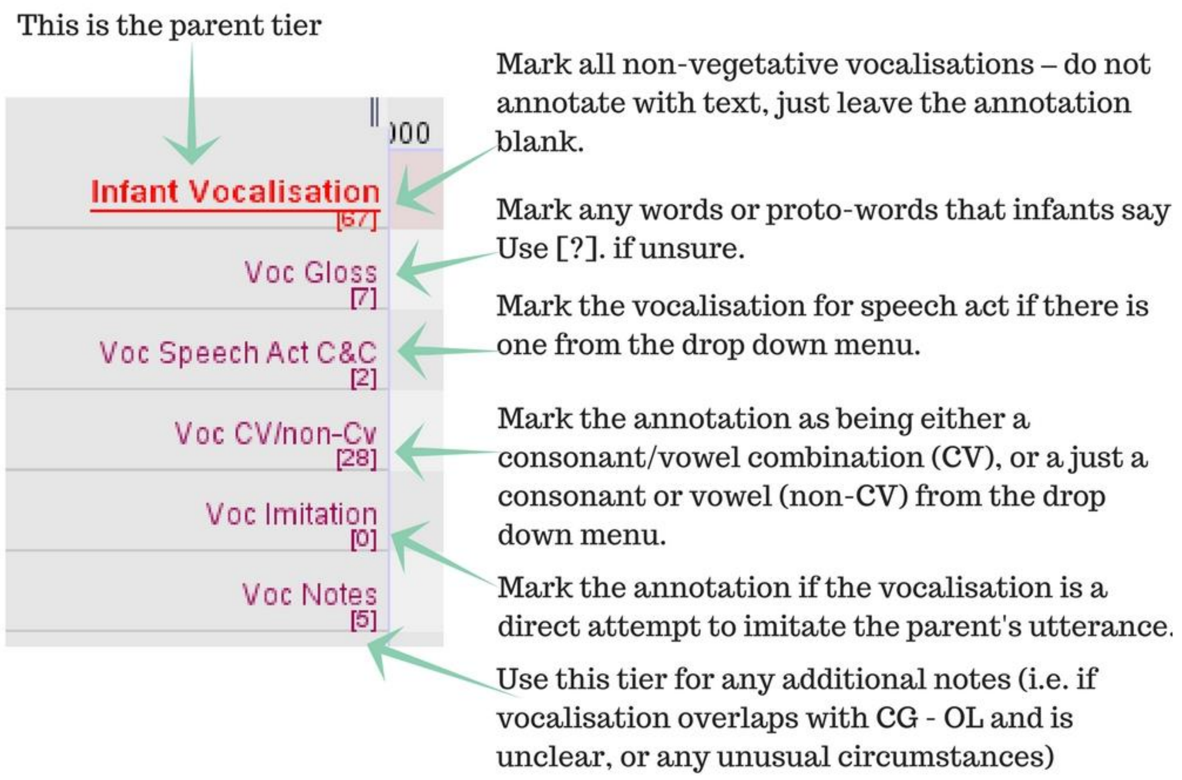
By the time your child begins school, they will be starting to develop the following skills. Please indicate the ways in which you think children are most likely to pick up these skills by ticking the appropriate box.

SKILLS	Is something children pick up naturally	Is something children learn from parents	Is something children learn at school
1. Saying “please” and “thank you” at the right times	O	O	O
2. Taking turns speaking and not interrupting	O	O	O
3. Using the right volume and tone when speaking	O	O	O
4. Keeping on topic in a conversation	O	O	O
5. Saying “hello” and “goodbye” appropriately	O	O	O
6. Using the right levels of eye contact when talking	O	O	O

8.2: Appendix C Naturalistic Coding Schemes

Coding Vocalisations at 18 months

Quick Guide



Different types of vocalisations:

- Vegetative = Crying, grunts, sighs, screaming, sniffing/sniffling, breathing noises, sneezing, coughing, yawning, sucking, hiccupping, burping and any other bodily functions
- Non-vegetative = Contains speech sounds i.e. consonants or vowels including babble, cooing, words and proto-words.
- Laughter and giggling are not speech sounds nor are they vegetative.

TIER: Infant Vocalisation

Mark all the times the infant makes non-vegetative vocalisations. You do not need to write anything in these annotations.

Do not code: Vegetative sounds and laughter/giggling (when the child is laughing uncontrollably. If the child says ha! Haha or hehe, it can be coded as Non CV). **However, do add L to the Voc Notes tier.**

Identifying Vocalisation Onset/Offset

- Onset: The beginning of the vocalisation is the first frame in which the infant can be heard to make any sound.
- Offset: The end of the vocalisation is the last frame where the vocalisation is still audible.

The .wav file can be useful for identifying the start and end of vocalisations. If there is a lot of background noise or if there is overlap between caregiver and infant vocalisations, estimate onset and end of vocalisation as accurately as is possible. After marking each infant vocalisation, listen to the annotation again to confirm that onset/offset is accurate.

- Vocalisations should be separately annotated. Vocalisations occurring less than 200ms apart should be marked with one annotation (Nathani, Oller & Neal, 2007). Utterances are identified using a breath-group criterion (Oller & Lynch, 1992). There must be a perceivable silence of 200ms between vocalisations to be considered separate. If there is not, these should be one annotation.

Tier: Voc CV/non-CV

TIER: Infant Vocalisations = mark the type of non-vegetative vocalisation the infant produced by selecting one of 3 options. These are:

- CV
- Non CV
- Unclear

These are explained below:

- **CV (Consonant-vowel)**

The infant produced a vocalisation containing a minimum of one consonant and one vowel in any order. For example, this combination could be either; a consonant + vowel (‘ba’), a consonant + vowel + consonant (‘dis’), or a vowel +consonant (‘un’).

Included as consonants:

- Fricatives (consonants produced by forcing air through a narrow channel made by placing two articulators close together, e.g. the lower lip against the upper teeth, in the case of ‘f’; the back of the tongue against the soft palate, in the case of German ‘x’, the final consonant of Bach)
- Ssssss sounds
- Liquids (a consonant sound in which the tongue produces a partial closure in the mouth, resulting in a resonant, vowel-like consonant, such as ‘l’ and ‘r’)

Not included as consonants:

- ‘h’ e.g. uh, uhuh, ha, ah
- Glottal stops (consonants formed by the audible release of air stream after complete closure of the glottis – sound is not made with vocal cords. It’s when the vocal chords come together, stop the breath; therefore stop the sound, and then release, e.g. ‘butter’ in a cockney accent or ‘uh oh’)
- Glides (a sound that is phonetically similar to a vowel sound but functions as the syllable boundary, rather than as the nucleus of a syllable e.g. ‘w’ and ‘y’ sounds. ‘y’ sound is often symbolised by ‘j’)

- **Non CV (other speech like sounds)**

The infant produced any other speech like sounds/vocal play sounds e.g. squeals and growls, yells, trills, consonant-like sounds (e.g. ssssss or ‘p’ sound with no vowel sounds at the end), vowel-like sounds (e.g. aaaaaah), snorts and raspberries. Raspberries are made labially (using lips) so are quite fricative, so include. Those made using the tongue (generally quite spluttery) are more of a grey area so do not include. A sigh ending through the lips, do not include as also grey area.

Examples of surprising Non CV = yeah, uh oh, hehehe, haha, hi, eh, uh, aah etc.

NB: Sometimes infants make really breathy vocalisations, include these but only if you hear some sort of vowel and/or consonant – don't include heavy breathing.

NB: all sounds need phonology. So if struggling, listen for phonology in the vocalisation. If not, it is likely vegetative.

- **Unclear**

This option is for when the infant made a vocalisation but you cannot distinguish what it is as the vocalisation is 'muddied' somehow e.g. by background noise, overlap with caregiver or the child whispered.

Common problems:

- *Vocalisations with toy in mouth*
  Sometimes a child will vocalise with a toy in their mouth. If they produce what sounds like a CV, it can sometimes be difficult to determine if the consonant came from the child or if it was produced due to the sound the child made on the toy resulting in a consonant sound. In these cases, use your judgement to mark as CV/Non CV and mark BL (borderline) in the *Infant Voc Notes* tier.

- *The "little sounds"/non-involuntary "effort sounds"*
  Sometimes infants produce short sounds that could sometimes be effort sounds. Those that are very breathy with no sound and those that appear involuntary i.e. forced/pushed out by effort, do not code as vocalisations. To make a judgement on whether or not the effort sound was involuntary or not, assess the child's activity and level of exertion.

- *Whispers*
  Code all whispers as CV or Non CV following the above guidelines unless you cannot make out what the vocalisation is, in which case code as unclear.

TIER: Voc Gloss

= Tier for words (and proto-words)

Coding words at 18 months is challenging because:

1. Not all vocalisations that 18 month-olds make are words
2. 18 month-old's words rarely sound like adult words
3. There is huge variability in the number of words that 18 month-olds can say. Some will not be producing any words at this age, while others will be saying quite a lot of words

When is a word a word?

Several factors can help determine when a word is in fact a word:

1. Context

    - Is there a *plausible target* in the immediate environment e.g. an object?
    - Could it *relate to an activity* that the infant/caregiver is engaged in?
    - Has the *caregiver used the word* in a preceding comment to the child?
    - Does the caregiver *identify* the word?
    - Does the child repeat an identical utterance in the same context and with the same potential referent multiple times?

2. Phonological Form

    - Is there at least a partial phonological match between the infant vocalisation and the target word? I.e., does the word sound at all like the adult word?
    - Does the child make use of phonologically plausible substitutions/processes appropriate for a child this age?

Bearing these factors in mind, categorise each vocalisation as:

- YES, the vocalisation is definitely a word. Transcribe the word orthographically in the *Voc Gloss* tier according to the CHAT conventions.
- MAYBE, this vocalisation might be a word. Transcribe the word orthographically in the *Voc Gloss* tier marking it to indicate uncertainty according to the CHAT conventions e.g. [?], <>[?]. You will need to be generous.
- NO, this is definitely not a word. Do not annotate anything in the *Voc Gloss* tier.

Transcription Conventions for Words

Transcription conventions are based on the CHAT format (http://childes.psy.cmu.edu/manuals/chat.pdf)

Primary abbreviated guidelines for transcribing child speech are listed below:

1. One utterance per annotation (p54)

An utterance is a unit of speech (Pan, Rowe, Singer, & Snow, 2005) bounded by either:

- grammatical closure
- pause of more than 2s
- transition in speaker

An utterance will usually end by grammatical closure (definition below), unless it is broken by transition in speaker or a pause of more than 2s. It is rare an utterance will be broken with a pause of more than 2s.

Grammatical closure is when an utterance ends with a full stop, exclamation mark or question mark.

For example: The following phrase of running speech should be transcribed as 5 utterances:

"ahhah what else is in here more cups, more cups, ahhah"

1. Ahhah!
2. What else is in here?
3. More cups!
4. More cups!
5. Ahhah!

Exceptions:

- <u>Tag questions</u> e.g. 'that's a blue ball, isn't it?'
- <u>False starts</u> e.g. 'that's a you've got a blue ball.'
- <u>Strings of counting</u>

For example: Counting One, two, three, four, five, six… should be transcribed as six utterances (or as many utterances as the child counts to!)

- One.
- Two.
- Three.

- Four.
- Five.
- Six.

For 18 month-olds, an utterance usually amounts to one word (or short phrase) e.g. ball = 1 utterance and all gone = 1 utterance.

2. Mark the end of all utterances with either **a full stop**; **a question mark** or **an exclamation mark** as appropriate, therefore end every transcribed utterance with either (**.**), (**?**) or (**!**)
3. Generally, only use lower case letters. Do not use uppercase letters for the first words of sentences. Use upper case letters only for proper nouns (and the word "I.", although this is not likely to appear in the speech of 18mos). Note: a proper noun is a name used for an individual person (including pet and character names e.g. Mummy, Igglepiggle, Raa Raa), place, or organisation.
4. Do not transcribe the infant's name or any other identifying piece of information (e.g. family member's names or the researcher's name instead, transcribe it as 'Childsname' or 'Experimentername' etc.
5. Use the standard spellings (see section below) for exclamations e.g. ahh or oh and interjections e.g. erm, hmm (Table 1) and for nicknames and colloquialisms.
6. Numbers should be written out in words i.e., one, two, three.

Useful symbols

[?] - Best guess (p. 72)

Use this symbol, if you think that the infant's vocalisation may be a word but you are not certain. **[?]** Marks uncertainty in relation to the single preceding word e.g., ball [?] or group of words (when they are enclosed in angle brackets) <all gone> [?].

Note: when you have coded all vocalisations revisit any words marked with [?]. Has this word been used elsewhere in the session? Can you remove the [?] or delete this target entirely?

[=? text] - Alternative Transcription (p.70)

Use this symbol, if it is difficult to choose between two possible transcriptions for a word e.g., in this case cat or car. <cat> [=? car].

xxx - Unidentifiable material (p. 41)

Use the code **xxx** when you are certain that the infant is saying a word but you are not sure what the word is. For each possible word use the xxx code. So if you think the child has said one word enter 'xxx' if you think the child has said two words 'xxx xxx' etc.

& - false starts, phonological strings and nonsense forms and sounds

- e.g. &d &d &d door
- e.g. &chuchuchu or &guga

Noises (p 38)

@o: - use for verbal imitations of animals, objects, vehicles etc. e.g. dog@o, cat@o, train@o (but not if they are using the conventional, onomatopoeic word to imitate e.g. woof, meow, choo-choo). In these cases write the word. For example, write oink if child says oink to imitate a pig but if child imitates a pig with a snort write pig@o). Other conventional words that you would write in the gloss tier instead of using @o are quack, beep, vroom, moo, baa. **NB. This replaces the old &=imit: transcription rule.**

&=____: - use for gasping, laughing, kissing, blowing sounds e.g. &=gasps, &=laughs, &=kisses, &=blows, &=sings, &=sighs, &=raspberries or other noises

&=sings: use this if the infant is singing along to a song that does not contain any conventional language, i.e. humming, dee dee, ee-eye-ee-eye-o. However, if they are clearly producing conventional words like "nod nod" or "itsy bitsy spider", write these in the gloss tier as words.

&=eats - for all manner of eating noises or **&=slurps** - for all manner of drinking noises

@o - use for sounds that do not fit sounds in the &=imit: category e.g., sizzles@o

Standard Spellings

<u>Table 1: Exclamations & Communicators (p. 49-50)</u>

Use these standard spellings for exclamations, as appropriate

Exclamation	Meaning	Exclamation	Meaning

ahhah	discovery relief,joy	Sh (shh)	silence
aw	Sympathy, affection	Ugh (urgh)	disgust, effort
ha(h)	triumph	Uhoh (uh oh)	trouble
haha	amusement	vroom	car noise
heehee	amusement	whee	exuberance
mmm	tasty, good	whoa	amazement
num	tasty	yay	a cheer
ow	hurt	yumyum	tasty
er	pause	uhhuh	yes
huh	questioning	uhuh	no
hmm	thinking, waiting	Uh/um	pause (any vowel)
hmm?	questioning	(wh)oop(s)!	Surprise or mistake
mmhm	yes	ooh	Surprise or delight
(wh)oopsadaisy	Surprise or mistake	uhoh	oops/oh dear

Petnames/unique family-specific words for Toys, Animals, Objects etc.

Families sometimes use special words for animals, pets, toys or people e.g. bebo for horse, taptap for shoes (P10 11m), nana for banana (P134 16m). These are essentially proto-words (when the infant produces a word-like structure. Proto-words precede first recognisable attempts at words and are recognised by parents as speech-like structures. They emerge around 12 months of age). Use the same spelling consistently each time this word is used by the child (and make a note in the *Infant Voc* Notes tier what the conventional English target is, i.e. horse or shoes in the case above). Add proto-words to this tier explaining the meaning.

Examples of commonly used words/phrases in South Yorkshire

- Nannan = Grandmother
- parp parp = Car
- Ta = thanks or thank you.
- Hidey boo = peekaboo
- Moo cow = cow
- Hiya = hi/hello

Popular Children's TV programmes and characters

- Raa Raa the Noisy Lion: Raa Raa, Zebby, Hufty, Topsy etc.
- Peppa Pig: Peppa Pig, George Pig, Mummy Pig etc.
- In the Night Garden: Iggle Piggle, Makka Pakka, Upsy Daisy etc.

Note: these are proper names and should be capitalised.

TIER: Voc Speech Act C&C

Refer to the separate document 'Coding Speech Acts at 18 months' for guidelines that apply to both this tier and the tier Gesture Speech Act C&C.

TIER: Voc Imitation

= drop down menu tier for marking whether the infant vocalization is a direct imitation of caregiver vocalization.

Imitation may be better coded during a second pass of the videos during a checking phase so that vocalisations, words, CV/non-CV and speech acts are coded during the first pass.

This scheme is adapted from Masur and Rodemaker (1999). To code as an imitation, they suggest that the word or vocalization imitated:

- Must have been in Joint Attention, i.e. the infant must have been able to hear it.
- Clearly evoked by the caregiver's behaviour rather than occurring independently, **and followed within 15 seconds after the caregiver's initial vocalization**.
- Doesn't have to be identical but must be similar to the original vocalization in at least 1 way (i.e. phonologically similar, tonally similar),

Key notes:

- Code all infant imitations of a parent's utterance, even if the infant has used the word spontaneously themselves earlier in the video.
- Occasionally, imitations can turn into games or routines in which the dyad takes turns to repeat the imitated word, like the following:
    - Caregiver: ball (turn 1)
    - Infant: ball (turn 1)
    - Caregiver: ball (turn 2)
    - Infant: ball (turn 2)

If the caregiver and infant carry this on for longer than 2 turns each, code as an imitative game (IM G) each time as this has turned into routinized behaviour (as per Eckerman, Davis & Didow, 1989; Note: Masur & Rodemaker, although acknowledging this in their paper, do not include imitative game as an option in their scheme. However, the routinized repetition of imitated words was fairly common in the 18 month videos and so this option was added by us).

Code from the drop down menu in the tier according to the following:

- Imitated word; code **IM W** if the vocalization is a direct imitation of caregiver's conventional word or phrase (i.e. ball, monkey), or a conventionally meaningful vocalization (i.e. uh-oh, yay).
- Imitated vocalisation; code **IM V** if the vocalization is a direct imitation of caregiver's language related vowel sounds or CV babbles, i.e. (aaah, ba-ba-ba), or non-language related noises (i.e laughter or fake coughs).
- Solicited imitated word or vocalisation; code **IM W/V[S]** if the word or vocalization has been explicitly solicited by the caregiver, i.e. if they have said directly before "can you say it?"
- Imitation from an object; code **IM W/V[O]** if the vocalization or word is a direct imitation of an object, like a toy, rather than the caregiver, i.e. if a toy has the sound of a car horn and the infant says 'beep beep'.
- Imitation from TV; code **IM W/V[TV]** if the vocalization or word is a direct imitation of something from the TV, rather than the caregiver, i.e. if there is a bee buzzing on television and the child says 'bzzzzz'.
- Imitative game; code **IM G** If the caregiver and infant each take 2 or more turns at repeating the imitated word in a routinized game, mark each subsequent turn (past 2) as **IM G**.

TIER: Voc Notes

= free text tier for additional comments and observations about each vocalisation

To note BL (borderline) for all borderline vocalisations and general comments/observations about specific vocalisations by making annotations in the *Infant Voc Notes* tier. The following list of codes is useful but not exhaustive. Describe any other questions or problems using free text.

- OL – overlaps with caregiver (only necessary if it is impossible to hear what the child is saying) i.e. using the unclear dropdown

- CH/C – hard to determine if caregiver or infant has vocalised i.e. using unclear dropdown. Sometimes the source of the sound is not clear e.g., did the infant or adult make the vocalisation or has the sound come from a toy or object in the environment? In these cases, watching the infant's mouth can help with disambiguation
- WH – the child whispered making it hard to determine what infant vocalised (only if the vocalisation is unclear (i.e. using unclear dropdown) and therefore can't determine if the vocalisation is CV or Non CV
- BG – background noise making it hard to determine what the infant vocalised (i.e. using unclear dropdown) and therefore can't determine if the vocalisation is CV or Non CV

TIERS: Notes and Offshot

- **TIER: Notes**

Make an annotation in this tier when the experimenter re-enters the room, this is the end of the play session, coding stops here, mark as END.

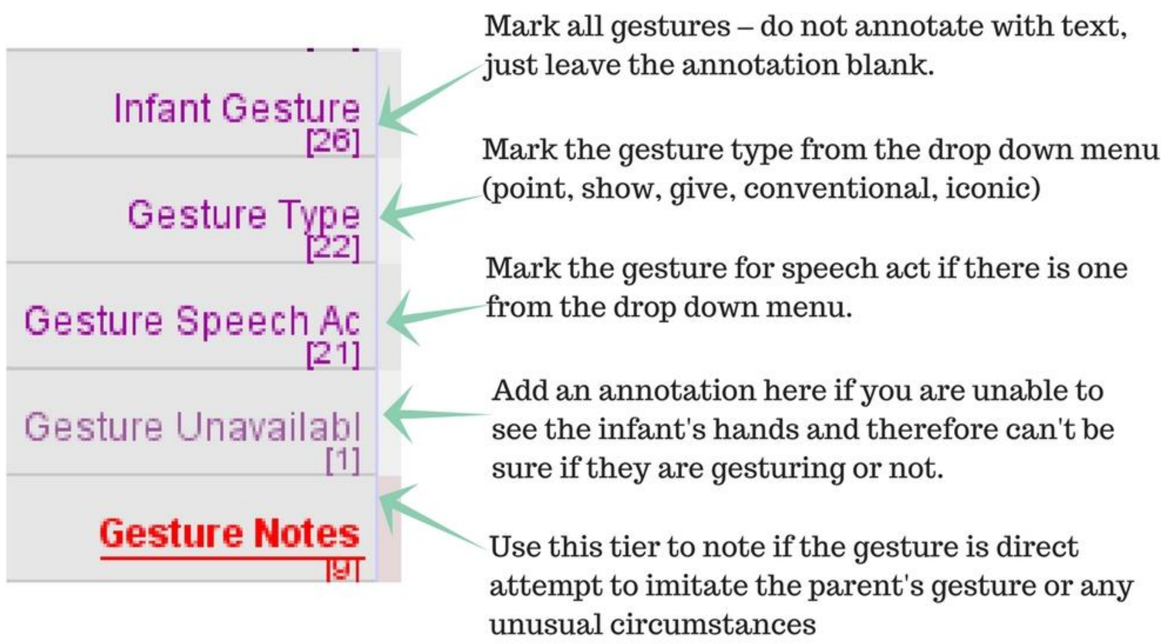
In addition, use this tier to add any comments about the session as a whole including technical information i.e. 1 camera stops recording, third party observers, breaks in session etc.

- **TIER: OFFSHOT**

Mark periods of time when the infant is OFFSHOT

Navigate through the video and mark any portions of the video where the infant is offshot on both camera angles in the *Offshot* tier. The annotation should **begin from the first frame where the infant's upper body (including the head/face) is not visible on camera and end on the first frame that the infant re-enters the screen on either camera**. Even if part of the child is on camera, for example the top of the child's head, or a shoulder, mark as offshot. The main reason for offshot is for when you cannot see where the child is looking and if they are gesturing. There may be the odd case where the child appears offshot for a short period of time but you can see the direction of their head and see their hands. This might not need to be included as offshot, however these cases are rare.

Coding Gestures at 18 months



TIER: Gesture Type

Select the type of gesture from the drop down menu, with options including:

Pointing

(see Matthews et al. (2012) Origins of the human pointing gesture: a training study)

You will need to code three different types of pointing. For both, the beginning of the gesture should be marked at the frame where the arm reaches maximum extension, and the end is marked at the frame where retraction of the arm begins.

***Index finger point* (mark *index_point*)**: While looking at an object or event of interest, the infant extends left or right hand (or both) such that the index finger(s) is clearly and visibly separate from the other fingers, which were **partially or entirely** curled back, and the index finger extends in the direction of the object or event being looked at.

***Open-hand point* (mark *open_point*)**: While looking at an object or event of interest, the infant extends left or right hand (or both) with a majority of fingers extended in the direction of the object or event being looked at.

Book/touch point **(mark as *index_point, but add 'book point' or 'touch point' in the* Gesture Notes Tier)**: While looking at an object or event of interest **in a book**, the infant extends left or right hand (or both) with a majority of fingers extended in the direction of the object or event being looked at and makes contact with the pages of the book.

***Object point (mark as index_point or open_point as you determine, but add 'pointing with object' in the* Gesture Notes Tier)**: Infant may use a toy he or she is holding to point to something distal.

For all of these pointing gestures, the following **conditions *have* to be met**, for you to code it as a point.

- The infant's arm has to be extended (not bent)
- The infant has to be balanced, i.e. not leaning forward (as if *reaching* for the object)

Pointing exceptions:

- Pointing with a flopped hand is included as an open point so long as above conditions have been met
- Point with a bent arm only when the child has no room to fully extend arm and clearly does not touch the object

Giving and Showing

For both, the beginning of the gesture should be marked at the frame where the arm reaches maximum extension, and the end is marked at the frame where retraction of the arm begins, **or at the point where the infant lets go of the object.**

***Show* (mark *show*)** – While holding an object with one or both hands, the infant holds out an object with their arm (or arms) extended towards the caregiver, specifically holding the object up towards the caregiver's face.

***Give* (mark *give*)** – While holding an object with one or both hands, the infant holds out an object with their arm (or arms) extended towards the caregiver, specifically extending the object in the direction of the caregiver's hands, or to deliver the object into the vicinity of the parent (but not towards the face). The object doesn't actually have to be taken by the parent for a give to have occurred – sometimes infants may extend an object, but draw back before handing it over – this could still be a give.

It is sometimes very difficult to tell these gestures apart since they are operationalised in similar ways, however, the following represent the main differences. In unclear cases, the following rules (in order) to ultimately decide:

Give	**Show**
1. Arm is fully extended outwards (not upwards) **towards caregiver hands or body**. **2.** Infant is **delivering**, not displaying the object (often, but not always, with palms downs).	1. Arm is fully extended upwards **towards caregiver face**. **2.** Infant is **displaying**, not delivering the object (often, but not always, with palms up).

Common problems:

- The object has to be held out by the infant, not shaken violently for this to be coded as a show or a give. A show or give can follow, precede, or break up a period of shaking, but a period of violent shaking of an object while the arm is extended at the caregiver is not a show or a give.
- Sometimes, a caregiver takes an object from infant's hands, and this might not be a give gesture. The object has to be extended towards the caregiver for it to be a give gesture. Use your judgement. Judge whether you think the object was offered to the parent before it was taken (if it was taken without being offered, this is not a give).
- If an object, e.g. a stacking cup is extended to the top of a tower (which also happens to be the direction of the caregiver's body) – it's a matter of judgement whether you think that is a give or just an attempt to stack the cup. Decide from whether you think that the infant is attempting to stack (not a give), or attempting to offer the object to the caregiver (a give).
- Sometimes, an infant might hold up an object for some reason other than to show it or give it to their caregiver. For example, sometimes play involves an object that the infant is holding being banged against another object that the caregiver is holding. If the infant holds out the object to bang the caregiver's object, this is not a give or a show. Likewise, if the

caregiver is holding out a part of a toy, and the infant puts the other part of the toy on it, this is not a show or give. Use your judgement.

- If a gesture starts as a show but turns into a give, code it as a show. If a gesture starts as a give but turns in to a show, still code as show. As a show is more sophisticated than a give, if a show occurs at any point in a gesture combination of show and give, code as a show.
- When an infant puts an object in their parents mouth, code this as a show (even though it is technically a give – as the object is extended towards the caregiver's face).
- Attempted gives are included as gives. A child may give a toy and change their mind, retracting it before the parent takes it.
- Often children hold up an object in order to throw it. Use your judgement on these occasions whether you believe that the infant was showing the object before the throw, or just trying to raise the object to get more of power for the throw. Normally, a pause before throwing (and if object extended in direction of caregiver's face) indicates that this is a show.
- In some cases, a child might hold an object out in front of themselves – this is not a show unless it is directed towards the caregiver's face.
- A walking give is tricky – use your judgement. Code as a give if you think the child is extending the object deliberately to the parent rather than just holding it in front of them as they walk.
- Occasionally, a child might place a toy on the floor in front of the caregiver – this is not a give.

Iconic

Iconic gestures **(mark iconic)**: These are gestures that "reference objects and actions by recreating an aspect of the referent's shape or movements…[they] represent physical objects or events" (Cartmill, Demir & Goldin-Meadow, 2012, p210).

Examples are:

- *Flapping arms* – to mean flying.
- *Panting gesture* – to mean dog.
- *Sniffing gesture* – to mean flower.
- *Arms out* – to mean airplane.
- *Imaginary steering wheel* – to meal car.
- *Blowing a kiss*

For each gesture, describe what it is in the Gesture Notes Tier, i.e. monkey action, blowing a kiss.

The beginning of the gesture should be marked at the frame where the infant begins the movement that forms the gesture, and should finish when retraction begins.

Conventional

***Conventional gestures* (mark conventional)**: These are gestures that have "an agreed meaning and form within a given community, and are therefore culturally shared symbols" (Cartmill, Demir & Goldin-Meadow, 2012, p210). They can be arbitrary or ritualized (from action).

- *Arm up*: where the infant raises both arms in order to initiate being picked up.
- *Wave*: where the infant waves with palm vertical (or close to vertical) and moving side to side (think "bye-bye!")
- *All gone*: the infant shrugs with palm of hand(s) facing up, similar to adults asking, 'where?'.
- *Clapping*: infant does at least one complete clap.
- *High five*: when the infant initiates or responds to a high-five in the conventional way.
- *Non manual gestures:* headshakes and head nods – these and only these are coded in context i.e. a headshake "no" or "nod" yes in response to caregiver.

For each gesture, describe what it is in the Gesture Notes Tier, i.e. nodding, clapping.

The beginning of the gesture should be marked at the frame where the infant begins the movement that forms the gesture (for clapping, the point at which the infant's hands are furthest apart before bringing them together; for nodding and shaking head, mark the first point that the infant's head starts to nod or shake).

TIER: Infant Gesture Unavailable

Mark all time that it is not possible to tell if the infant is gesturing. This includes all the time where the infant's arms (or one arm), or head, were not visible, and it was possible that they could have gestured. So put an annotation in this tier if you think that, had the infant gestured, you would not have seen it. Begin annotations from the frame that you judge that it's not possible to see gestures, to the last frame where you judge that it's not possible to see gestures.

Note: when you have put an annotation in the *Infant Gesture Unavailable* tier, don't code any gestures on the *Infant Gesture* tier for the time when this is marked. Annotations can start exactly at the point where annotations on the other tier end (or vice versa) but make sure there is no overlap between annotations on the *Infant Gesture* tier, and the *Infant Gesture Unavailable* tier.

TIER: Infant Gesture Notes

Use this to exceptional or unusual circumstances and for justifications for annotation choice if needed; to note BL (borderline) if you feel the gesture is borderline.

Gestural Imitation

Also, use this tier to record if the gesture is a direct attempt to imitate a parent's gesture. If it is, add the code **IM G**.

Coding Speech Acts at 18 months

Follow the diagram below to code for vocalisation and gesture intentions and speech acts:

Is the vocalisation/gesture **communicative/is there a discernible communicative intention*** behind the vocalisation/gesture?

Yes

1. If intentional*, next decide whether the vocalisation/gesture is:

a) Initiative*; initiated** by the child independently of the parent's utterance?

b) Responsive**;** a direct **response** to or acknowledgement of the parent's previous utterance?

c) Other; intentions that don't traditionally fit into the initiative or responsive divide.

No

2. If unintentional**, do not add a code to the tier, just leave blank.

IMPORTANT: If the vocalisation/gesture is a repetition***** and a duplication of the intention, **you would also only code the first occurrence of the speech act** and leave the subsequent repetitions blank (adding REP to the

Uncodeable

3. ALL vocalizations where the child is **off-shot (off camera) should be marked as uncodeable**. Offshot is defined as any part of the video where the infant's upper body (including head and face) is not visible and you therefore cannot see gestures and direction of gaze. Select **uncodeable** from the drop down menu.

ALL gestures where you are unable to see the infant's hands and therefore cannot tell whether they have gestured or not, select Infant Gesture Unavailable from the **Gesture Unavailable tier.**

a) If initiative***, decide whether the vocalisation/gesture is one of the following speech acts:

i) Comment on action
ii) Comment on object
iii) Request for action
iv) Request for object
v) Request for information

b) If responsive****, decide whether the vocalisation/gesture is one of the following speech acts:

i) Answer (to a direct question)
ii) Acknowledgement (a sign of agreement or compliance)
iii) Protest (a refusal)

c) If **other**, decide whether the vocalisation/gesture is one of the following:

i) **Greeting**
ii) **Game embedded behaviour**

***Intentional vocalisations/gestures**

In order to classify a vocalisation/gesture as intentional, Coggins & Carpenter (1981) suggest that:

"Communicative intent, like intelligence, is a presumed mental process that cannot be directly observed; instead, it must be inferred from the context. In order to judge a behavioural sequence as intentional, it is necessary that **the child be jointly participating in some shared activity" (p.242)**

To this, we also add cases where the parent is unengaged and the infant calls and directs their attention in order to **initiate a shared activity**.

In sum, the child and parent must be either:

a) Clearly engaged in joint attention (i.e. parent and child are jointly engaging with some toys, they do not have to have constant eye contact, but they are clearly attending to the context together)
b) Be attempting to establish joint attention (i.e. the child attempts to establish joint attention over a new object)

In terms of behavioural markers, to be coded as intentional, they also recommend that the utterance/gesture should also be accompanied by **one or more of the following**:

- (C&C criteria) Close physical or recent close **physical proximity** between mother and child.
- (C&C criteria) Recent **gestural, vocal or verbal contact** between mother and child.
- (C&C criteria) **Child gazes towards mother** within 3 seconds of a communicative intention act (this is not necessary if a) or b) are in evidence).
- (GS added) ***Context (is the child clearly in joint attention with the adult, or are they happily playing on their own? If they were playing on their own without anybody around, what are the chances they would still make the same vocalisation and it is therefore communicatively unintentional?)***

Differentiating between intentional & unintentional behaviours

The difference between A) intentional and B) unintentional behaviours is that you will be able to reason how intentional behaviours fulfil some of the criteria set out above (the dyad is in shared activity, close proximity, eye contact), and how unintentional vocalizations/gestures do not. **It is also helpful to think about whether the infant might have still vocalised/gestured if they were doing the activity on their own. If yes, it is unlikely that they were trying to convey an intention. It is also helpful to ask yourself whether the utterance/gesture is classically triadic in nature, i.e. addressed to somebody about something?**

****Unintentional vocalizations /gestures**

Bear in mind that VERY MANY vocalisations at this age will have no obvious intention - infants at 18 months will often vocalize without a clear intention, with no accompanying cues, such as gestures and eye contact, and often seem like they are doing it for themselves, for self-enjoyment and not to signal an intention to their interlocutor.

If there is no obvious intention do not annotate anything, leave this tier blank and do not select a category from the drop down menu. Unintentional vocalizations often tend to be those such as the infant babbling, humming, singing, repeating words, proto-words or phonemes to themselves without engaging with anything or anybody around them.

In deciding whether a vocalization is intentional, it is helpful to think about whether the infant might have still vocalised if they were doing the same activity entirely on their own. If yes, it is unlikely that they were trying to convey an intention to their interlocutor. It is also helpful to ask yourself whether the utterance is classically triadic in nature, i.e. addressed to somebody about something?

*****Initiative**

The vocalisation/gesture has been Initiated by the child independently of their parent's utterances, and is therefore independently formulated.

Initiative types of speech acts do not necessarily directly relate to adjacent utterances. What infants intend by initiative speech acts can be independent of the existing conversational discourse and are done so without regard to how the intention relates to prior utterances.

See table below for expansion of conceptual and operational definitions, with examples.

******Responsive**

The vocalisation/gesture is a response to the parent's previous utterance or action (which may have been a question, a suggestion, a movement), and is therefore responsive.

Responsive types of speech acts do directly relate to adjacent utterances. What infants intend by responsive speech acts takes into account both their own intention and how that intention appears to function in conversation (i.e. how the intent relates to immediately adjacent utterances).

A useful question to ask to distinguish between a) an initiative vocalization/gesture, and b) a response vocalization/gesture is whether you think it likely that the infant's vocalization/gesture would have realistically happened without the parent's previous utterance or action? If yes, the vocalization/gesture may be initiative, if no, it is likely that the vocalization/gesture is a response.

See table below for expansion of conceptual and operational definitions, with examples.

*******Repetitions**

An intentional behaviour that is repeated one or more times and which refers to the SAME object or action should be coded as having a speech act on the first occurrence only. For example, the infant picks up a picture of a banana and says "banana" to comment on it. The child goes on to repeat "banana" twice, but these last two utterances are **merely repetitions with same underlying intention** and should not be coded as distinct speech acts. Therefore, this infant, would be given a **comment on object** speech act code for the first time they said banana but not for the two further times. **When this happens, write REP in the Voc Notes box.**

Initiative Vocalisations & Gestures

There are 2 main types of initiative communication, comments and requests and the following should help to distinguish between them:

Comment

Intentions: Showing, Telling
Key gloss: "Look!"

From C&C: An intentional behaviour that directs the listener's behaviour towards some observable referent, or the action of some observable referent.

Can be a comment on:

- An action
- An object

In response, the caregiver will either just take or look at the object in question in acknowledgement, there is no resulting action to perform.

If infant awaits or expects a response from caregiver**, it is an acknowledgement they will get (either verbal or through gaze), rather than an action**.

Request

Intentions: Asking for action
Key gloss: "Do this!"

From C&C: An intentional behaviour whereby the infant solicits services from a listener through vocalisations or gestures and awaits/expects a response.

Can be a request for:

- An action
- An object
- Information

In response, **the parent will usually perform the requested action, or at least there is an obvious action that they could have performed**, i.e. handing over an object to the infant, or acting on an object so that it moves, or moving an object somewhere.

Infant usually awaits or expects a response from caregiver, that is an action, rather than just a verbal or gaze based acknowledgement.

Vocal Comments
Include:

Vocalising during actions, i.e. "oh-oh" when things fall over, "yay", "wee", "wow".

Using labels to refer to things around them that are not asking for help to obtain, "monkey", "there", "this", "that".

Using adjectives, "nice"

Saying "aw" while hugging.

Gestural Comments
Include:

Index pointing - at referents to share attention (not to obtain, look at that!).

Gives - purely to share an object in caregiver's attention so that they take it/look at it.

Shows

Iconic – i.e. performing a monkey action when a monkey is mentioned.

Vocal Requests
Include:

Using labels to refer to things around them that they are asking for help to obtain, "monkey", "there", "this", "that".

Whining/frustrated sounds that accompany pulling of caregiver hands.

"Help", "stuck", "gone", "off"

Absent entities – "juice", "biscuit" requests for object, "daddy" "petsname" RFI Questions, "what's/where's this?" RFI

Gestural Requests
Include:

Index pointing - at referents in order to obtain them or to have the caregiver perform some action on them.

Gives – giving an object to caregiver so they can perform an action with it.

Responsive Vocalisations & Gestures

There are 3 main types of responsive communication, answers and acknowledgements/protests and the following should help to distinguish between them:

Answer

Intentions: Providing information in response to a question.
Key gloss: "This is the answer!"

From C&C: Infant responds to a request for information with semantically appropriate data.

The key to deciding between answering and acknowledging is in the nature of the parent's previous utterance, code as answering if the child is responding to a question that requires specific information as an answer, and is not an agreement to a suggested behaviour.

"What's that?" "where's X?" "Is that the X" "What colour is this?" "what does the monkey do"?

Vocal Answers
Include:

Verbal affirmations or negations: "yes, "no" to "are you hungry?"

Using labels and the locative there to answer questions like "what's that?", "where's this?"

Making animal noises in response to "what does the monkey do?"

Gestural Answers
Include:

Index pointing - to locations or referents that answer "where/what's that?"

Conventional – nodding or shaking head to indicate yes/no.

Show – locations of referents.

Iconic – i.e. performing a monkey action when asked "what does the monkey do?"

Acknowledge/Protest

Intentions: Providing a notice of compliance/agreement and non-compliance in response
Key gloss: "I agree/let's do it!"

From C&C: Infant provides notice that the parent's previous utterance has been received.

The key is in the nature of the parent's previous utterance, code as acknowledging if the child is responding to any parent's suggestion for action or behaviour, e.g. "shall we read?" "do you want to colour?". Although these are questions, the infant is indicating their agreement or non/agreement, and not providing specific information.

IMPORTANT: Code ALL vocal and gestural imitations as acknowledgments.

Vocal Acknowledgements
Include:

Verbal affirmation for acknowledgment ("yes" "yeah" "ok") in response to a suggestion for an action or behaviour by the caregiver (negation for protest, "no")

Any vocal acknowledgement that seems to be providing notice of uptake of the previous utterance by caregiver.

Vocalising while accepting an object, using "thank you", "ta".

Any vocal imitation.

Gestural Acknowledgments
Include:

Acknowledge: Nodding head to indicate agreement to a suggestion for an action or behaviour by the caregiver.

Acknowledge: Gives an object to caregiver when it has been requested.

Protest: Shaking head to protest against a suggested behaviour by caregiver.

Other types of Vocalisations & Gestures

There are 2 main types of other speech acts to look out for, they can be either initiative or responsive but fall outside the categories discussed in the C&C scheme. Ninio & Snow (1996) suggested the C&C should include:

Greeting

Infant is marking the new or existing co-presence or actual/impending separation between themselves and the caregiver, experimenter, or an object.

Infant will verbally mark the arrival or exit or somebody or something, "hello", "bye bye", or use the conventional waving gesture.

Infants will often do this when books are closed or toys put away as well as in more conventional contexts like waving hello to

Game embedded behaviour

Infant makes the appropriate verbal or vocal turn in a routinized game or song.

Infant verbally, vocally or gesturally marks their turn in a game or song.

SINGING

Code all singing/humming as game embedded behaviour and include as &=sings in the ***vocalisation gloss tier*** if the song doesn't contain words. If the song contains words, code words as you would normally, i.e. "wheels on the bus".

However, in the Voc Notes section, add the following and record whether the infant has started to sing spontaneously and has thus initiated, or whether the infant is responding to the caregiver's singing.

Infant initiated: add "&=sings; I"
Caregiver initiated: add "&=sings; R"

IMPORTANT: gestures that are part of songs should be seen as action and not viewed as gestures!

Other examples of routines are:

- A game of cheers; infant and caregiver says cheers to each while clinking cups or glasses.
- Incy wincey spider/ring-o-roses
- Infant and caregiver take turns pretending to answer a telephone.
- Infant provides the next turn in counting games (i.e.

<u>If you're unsure, or cannot make a decision, use the following three categories:</u>

<u>Intentional but unclear</u>

The infant is vocalising or gesturing with intention but the exact speech act is obscured by the context, or it is impossible to tell between two speech acts (say requesting and commenting).

Eventually, it is best to come to a decision using the rules provided.

<u>For vocalisations: Uncodeable</u>

It is impossible to assess the vocalisation for intention because the context is obscured.

Infant is off-shot (off camera). Offshot is any video where the upper body of the infant (including head/face) is not visible.

The context is obscured, i.e. the infant has their back to the camera and is obscuring the situation, or it may be that although you can see the infant's face, it is actually unclear what the child is doing with their hands, and therefore impossible to assess whether the vocalization is intentional.

<u>For gesture: Gesture Unavailable</u>

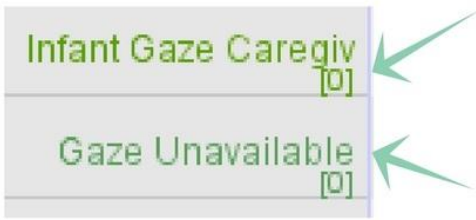
It is impossible to assess the gesture for intention because the context is obscured.

Infant is off-shot (off camera). Offshot is any video where the upper body of the infant (including head/face) is not visible.

The context is obscured, i.e. the infant has their back to the camera and is obscuring the situation, or it may be that although you can see the infant's face, it is actually unclear what the child is doing with their hands, and therefore impossible to assess whether the gesture is intentional.

Coding Gaze at 18 months

Quick Guide



Use this tier to record the duration of any looks that the infant gives to their caregiver.

Use this tier to record any times that you are unable to see the infant's gaze and therefore cannot tell whether they are gazing towards their caregiver or not.

TIER: Infant Gaze Caregiver

Mark all time infant spends looking at caregiver's face, from the frame that you judge to be the beginning of the look, to the last frame where you judge that the infant is looking at the face. Type "Gaze caregiver" in these annotations.

This is surprisingly clear to do in the majority of cases. There are a couple of things to consider when you are making this judgement though.

- Often the camera angle is not ideal. Sometimes, if the child is side-on, their eyelashes, or the orientation of their head, might indicate whether they can be looking up or not. If they are on the floor, looks to caregiver's face tends to involve a look upwards – but obviously this is not always the case. If you feel that you genuinely cannot tell if the infant is looking at the caregiver's face or not, use the *Infant Gaze Unavailable* tier (see below)
- When the infant is very close to the caregiver, it important to try as best as you can to differentiate looks to the caregiver's face from looks to their necklace or chest area (which is not gaze to caregiver's face)
- When infant is being held by the caregiver, this coding needs to be sensitive to the fact that when the infant is held to the side of the face (e.g. on the parent's shoulder) the infant is not normally gazing to caregiver's face, or can't possibly, because their head is behind their caregiver's

- When child is sat on caregiver's lap, the likelihood of gazes to the face is small – infants really have to turn their head to look to the caregiver's face when they are in this position

Common problems:

Small objects in front of the caregiver's face: If a caregiver is holding an object in front of their face that the infant is looking at (and you think that the infant can still see their caregiver's face around the object) mark this as a gaze to caregiver's face. Equally if the infant is watching an object or the caregiver's hand, and this moves in front of the caregiver's face, this is still a look to caregiver's face for the period of time the infant is gazing in that direction.

Large objects in front of the caregiver's face: If there is a large opaque object in front of the caregiver's face that you think completely obscures the caregiver's face, the infant is *not* looking to the caregiver's face (even if they are looking in the right direction). However, if there is a transparent object (like a see-through scarf) on the parent's head, and the infant looks in that direction, this could be a gaze to caregiver's face.

Blinking: If the infant blinks during a gaze to caregiver's face, there is no need to break up the coding. However if the infant closes their eyes for what you think is longer than a blink, then do not code this time with the eyes closed as gaze to caregiver's face. Finish the annotation when they close their eyes, and start a new annotation when they open their eyes.

Mirrors: If the infant seems to be looking in a mirror (often these are in children's books. Also on the phone in the structured play toy bag), and you think that they could be looking at the caregiver's face *in the mirror*, even if they are facing away from them. You need to use the next category (*Infant Gaze Unavailable*), because we could almost certainly never be sure about this.

Caregivers moving into the infant's line of sight: Occasionally, an infant is looking in a direction, and their caregiver's face moves into their line of sight, so that the infant is effectively gazing at the caregiver's face. If you judge that this has happened, code this as gaze to caregiver's face. If you don't think it's possible to tell, mark this as *Infant Gaze Unavailable*.

TIER: Infant Gaze Unavailable

Mark all time that it is not possible to tell if the infant is looking to the caregiver's face. Begin the annotation from the frame that you judge that it's not possible to tell, to the last frame where you judge that it's not possible to tell. Type "Gaze unavailable" in these annotations.

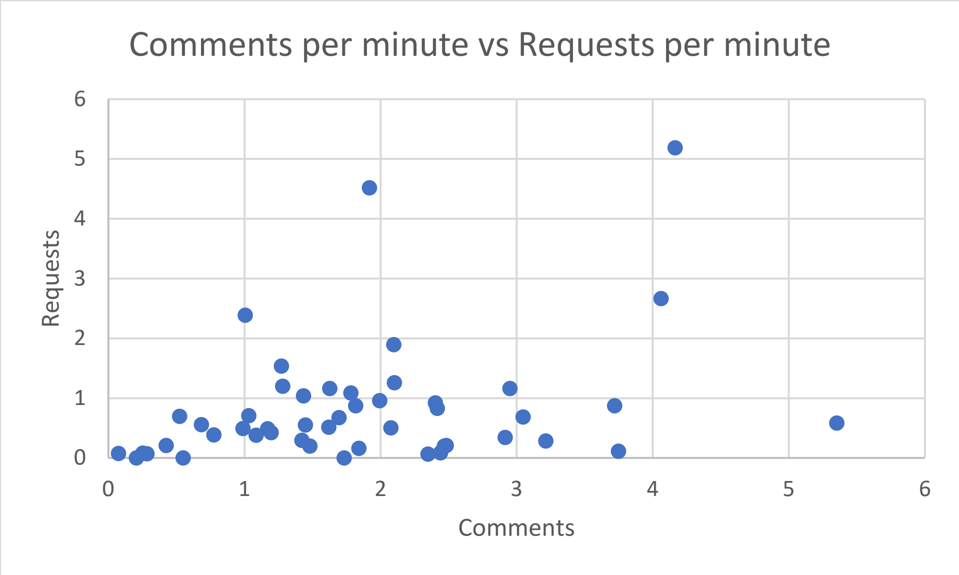
Annotations on this tier are for when it is *possible* that the infant is looking to the caregiver's face, but it is not possible for you to conclusively say if they are or not. Sometimes this will be because the infant's eyes are not in shot, but you think that the position of their head means it is possible that they could look to the caregiver's face and you wouldn't know.

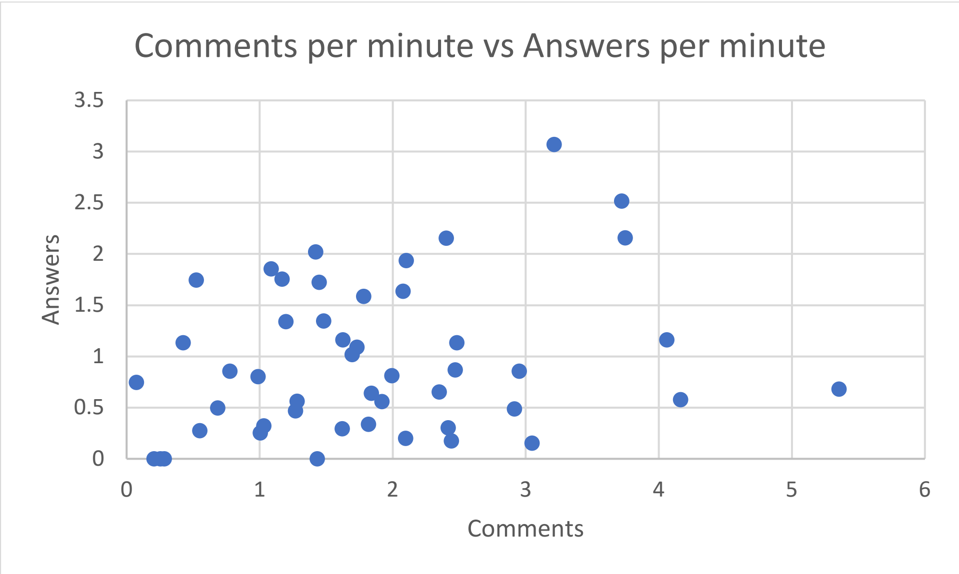
Also, sometimes, you won't know the position of caregiver's face because they are completely out of shot. If the infant is looking down at the floor, or an object that they are playing with, then you don't need to mark this as gaze unavailable (because you know they are not looking to the caregiver's face). If the infant looks up somewhere, and you think that this could be to the caregiver's face (but you don't know where that is), you should mark this tier.

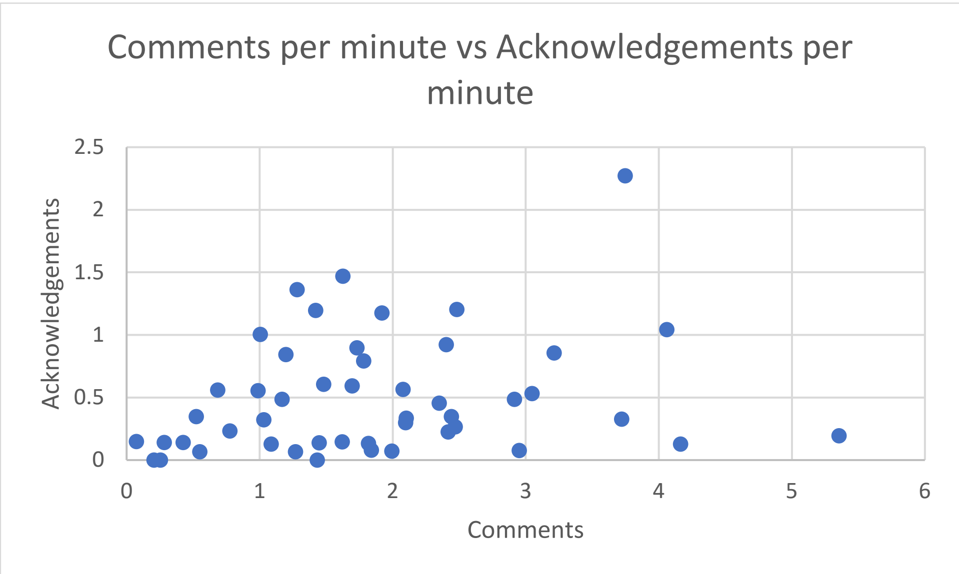
Note: when you have put an annotation in the *Infant Gaze Unavailable* tier, don't code any gaze on the *Infant Gaze Caregiver* tier for the time when this is marked. Annotations can start exactly at the point where annotations on the other tier end (or vice versa) but make sure there is no overlap between annotations on the *Infant Gaze Unavailable* tier, and *Infant Gaze Caregiver* tier.

Appendix D: Scatterplots for Relationships Between Variables in Chapter 3

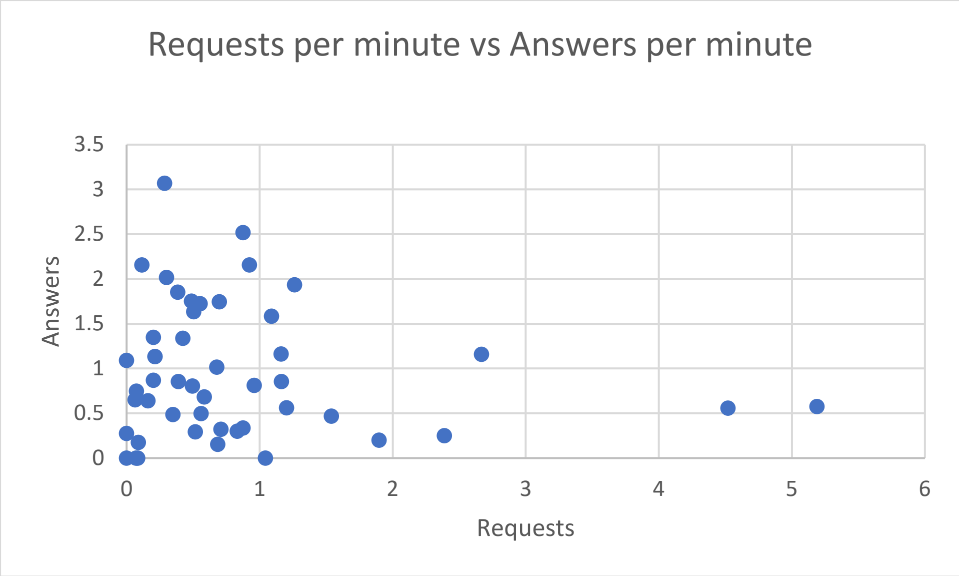
Interrelations between Communicative Intentions

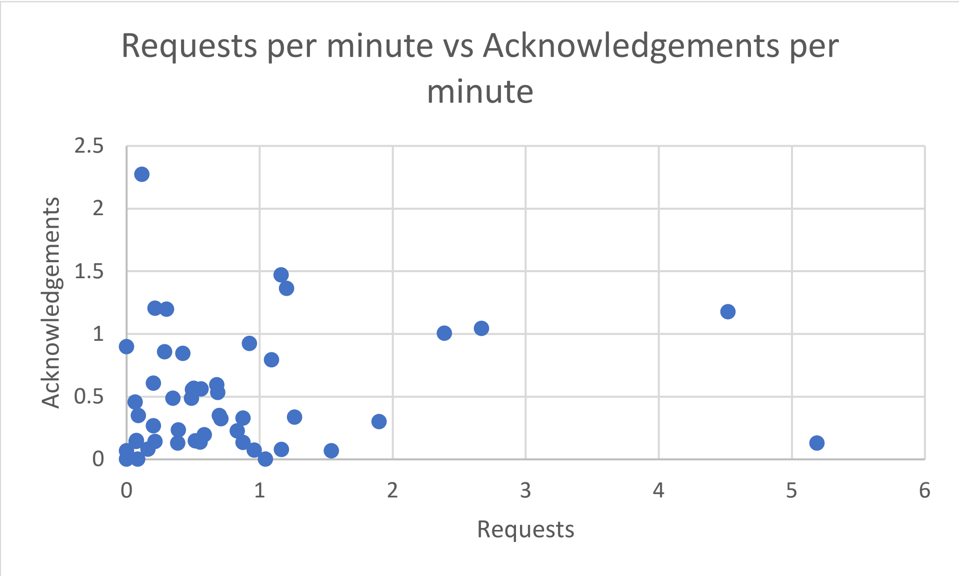


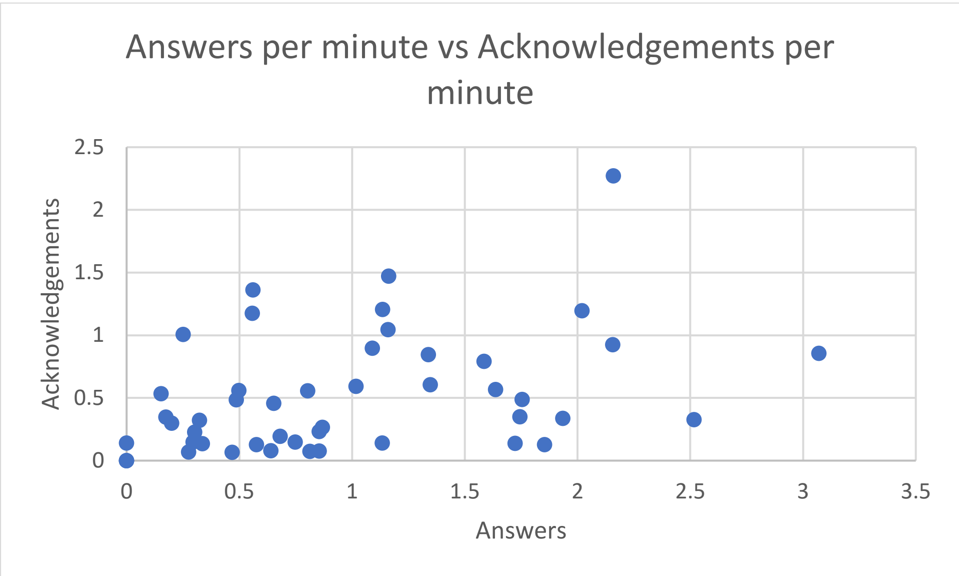




Appendix D: Scatterplots for Relationships Between Variables in Chapter 3

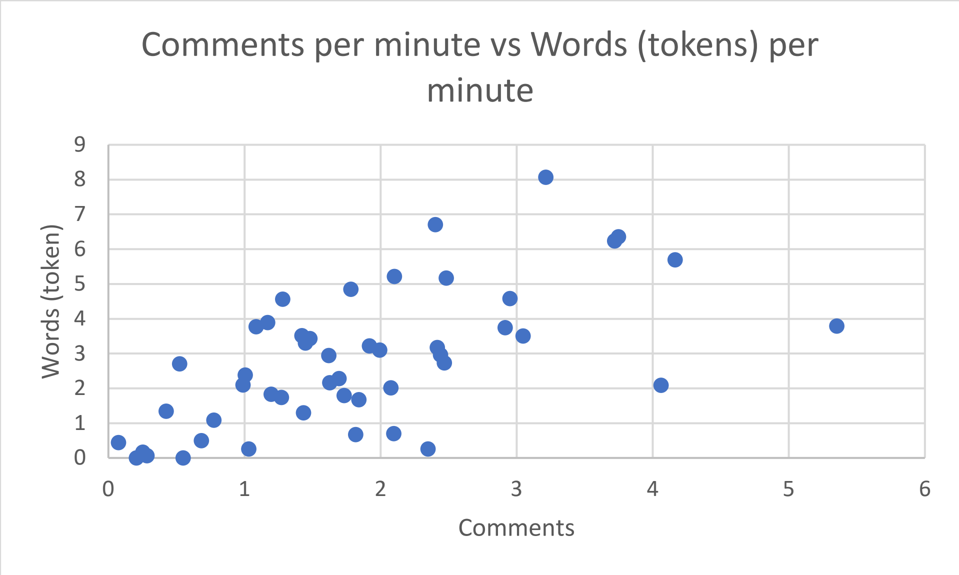


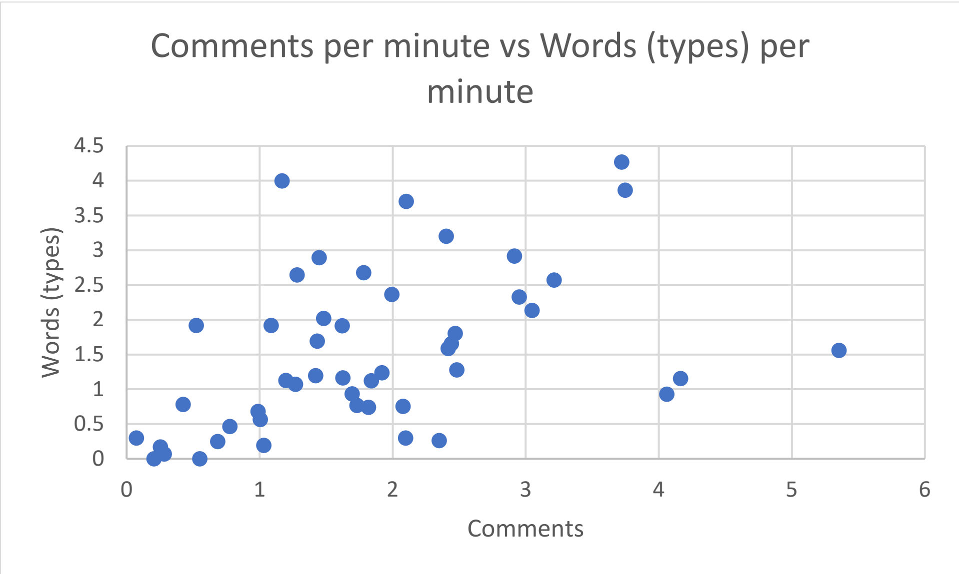


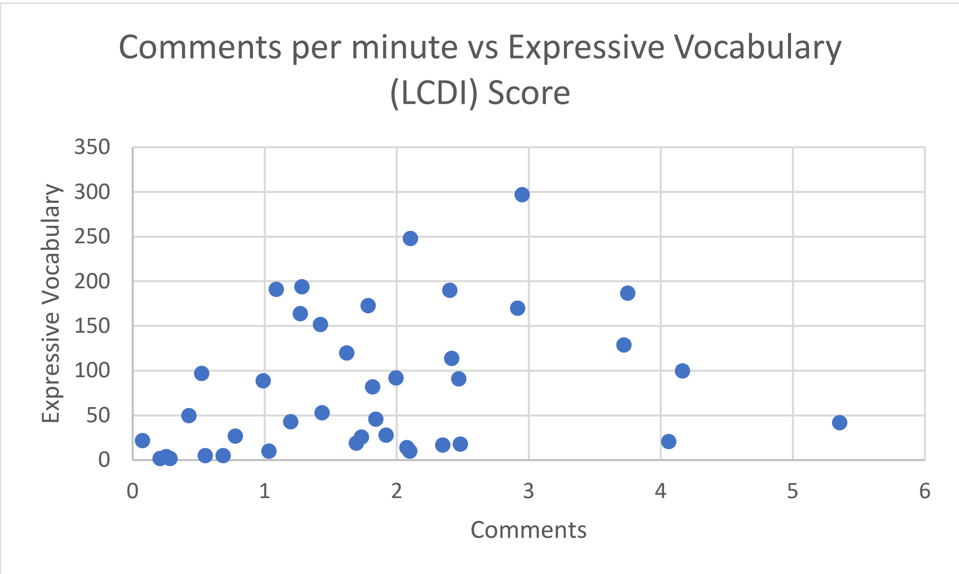


Appendix D: Scatterplots for Relationships Between Variables in Chapter 3

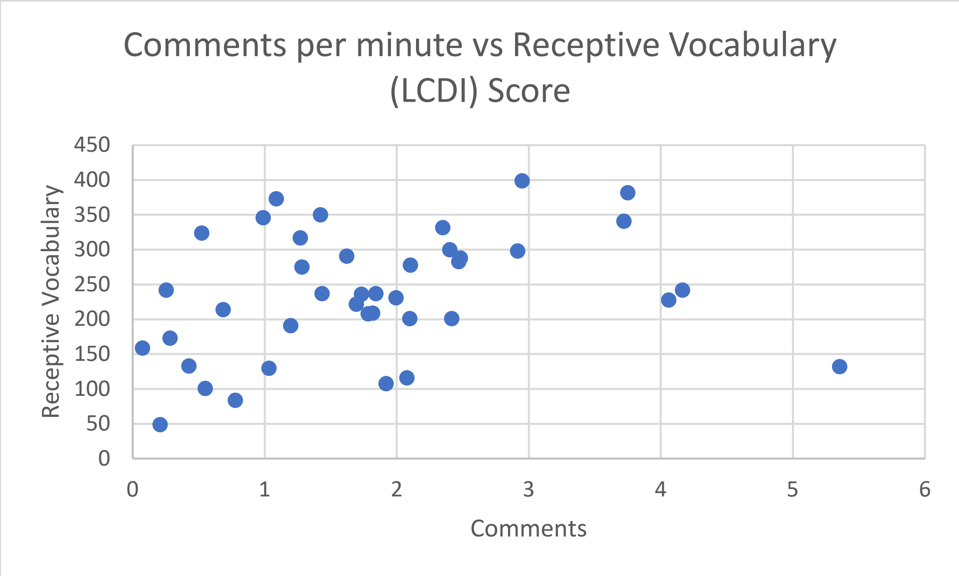
Correlations between Communicative Intentions and Formal Language

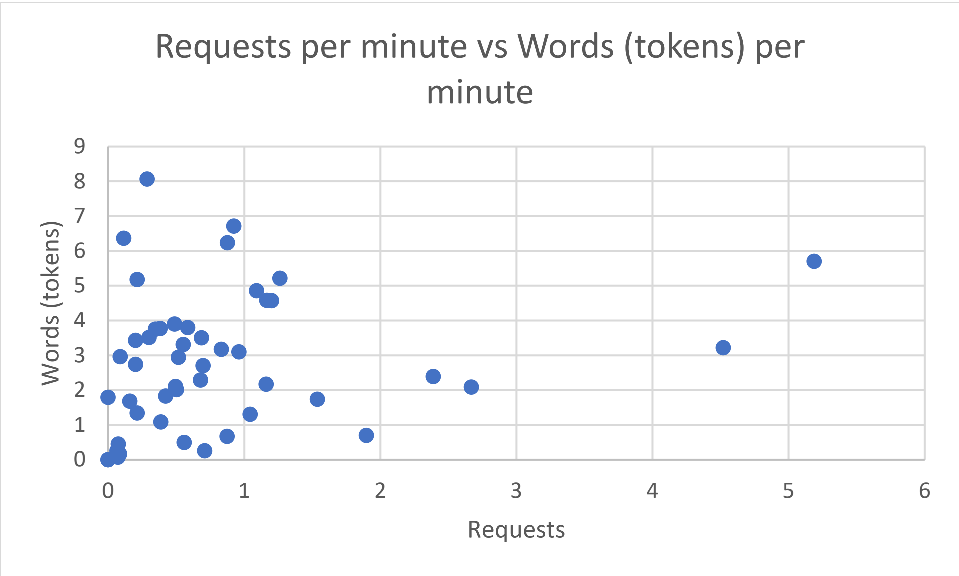


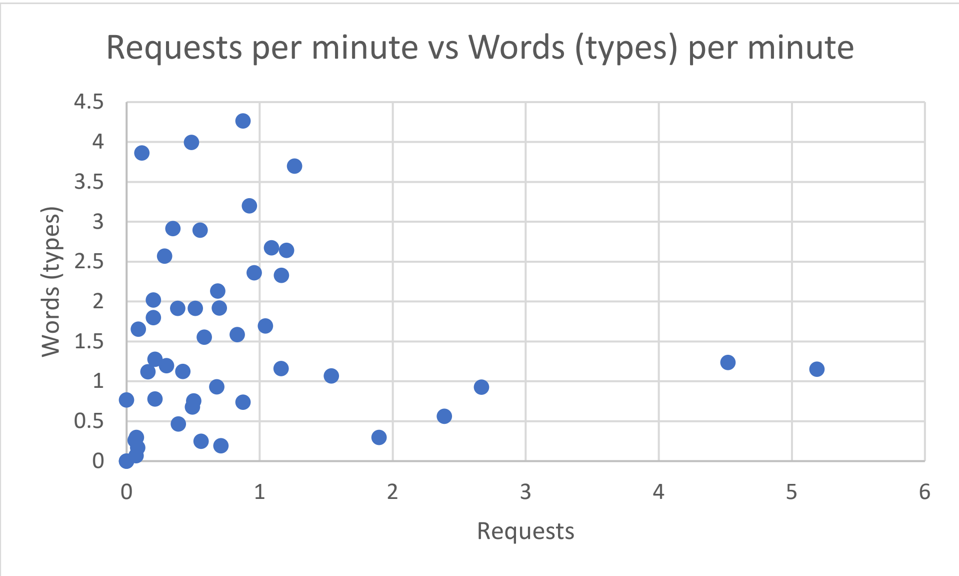




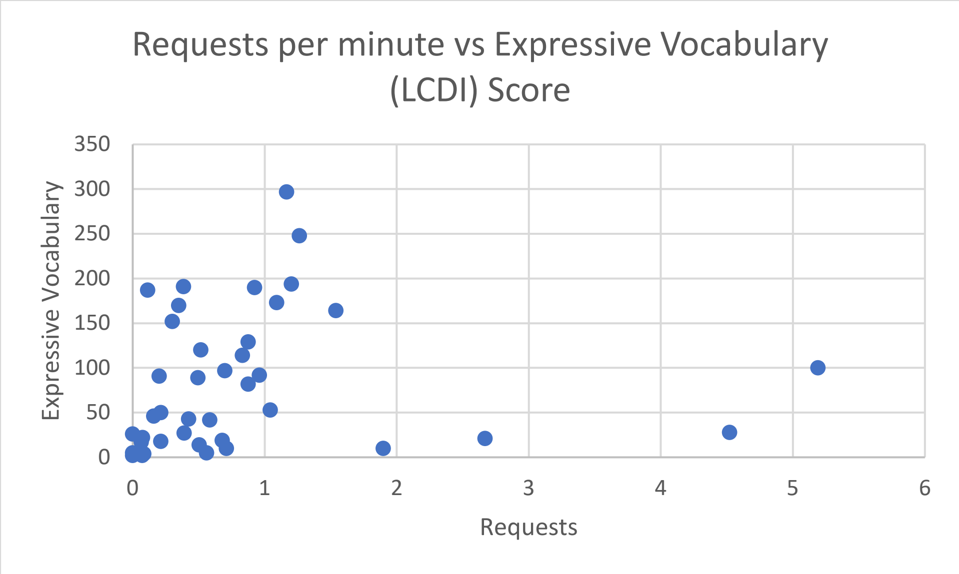
Appendix D: Scatterplots for Relationships Between Variables in Chapter 3

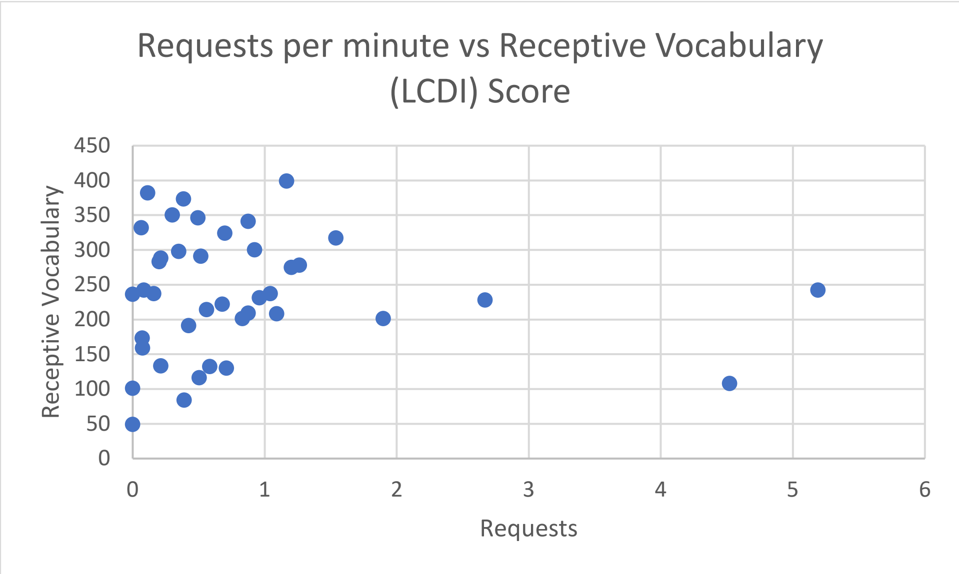


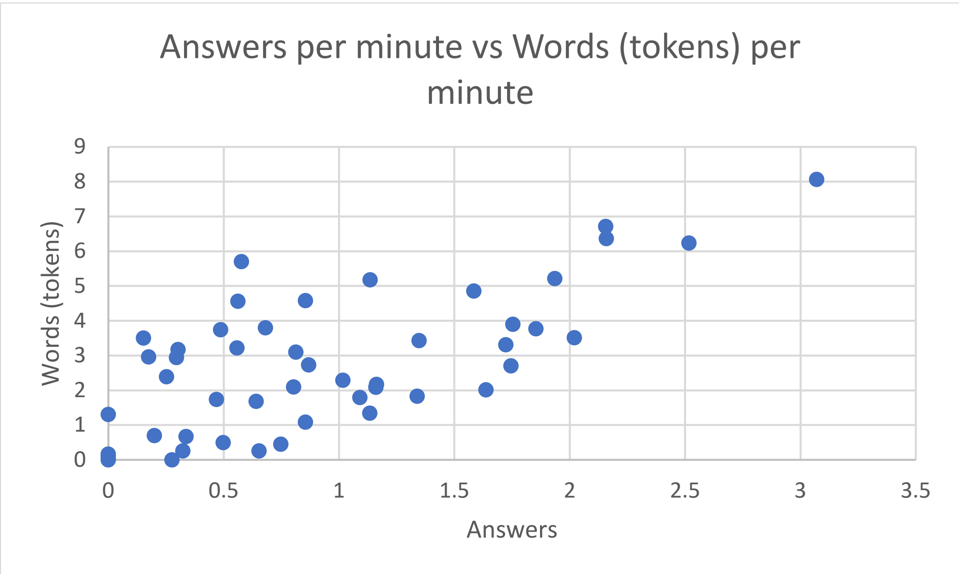




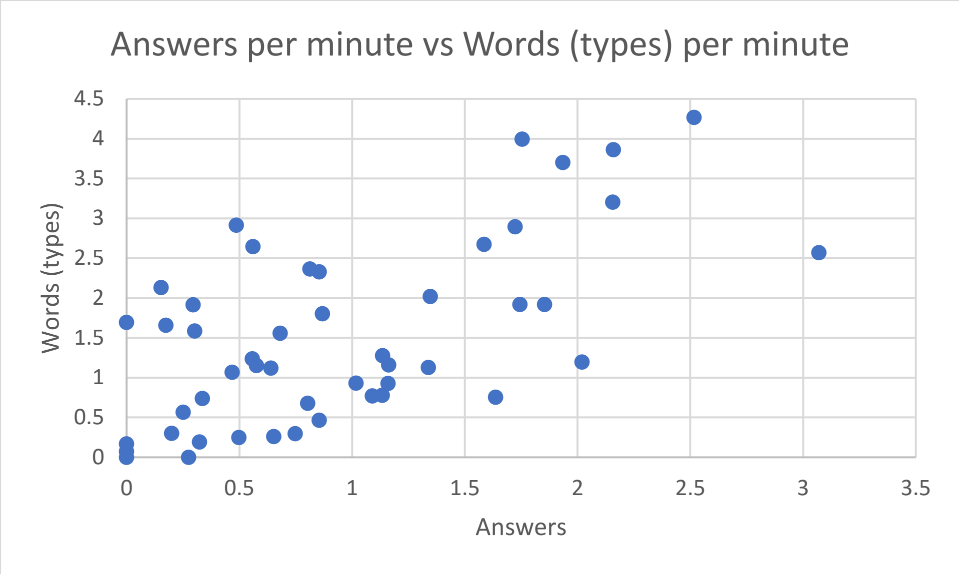
Appendix D: Scatterplots for Relationships Between Variables in Chapter 3

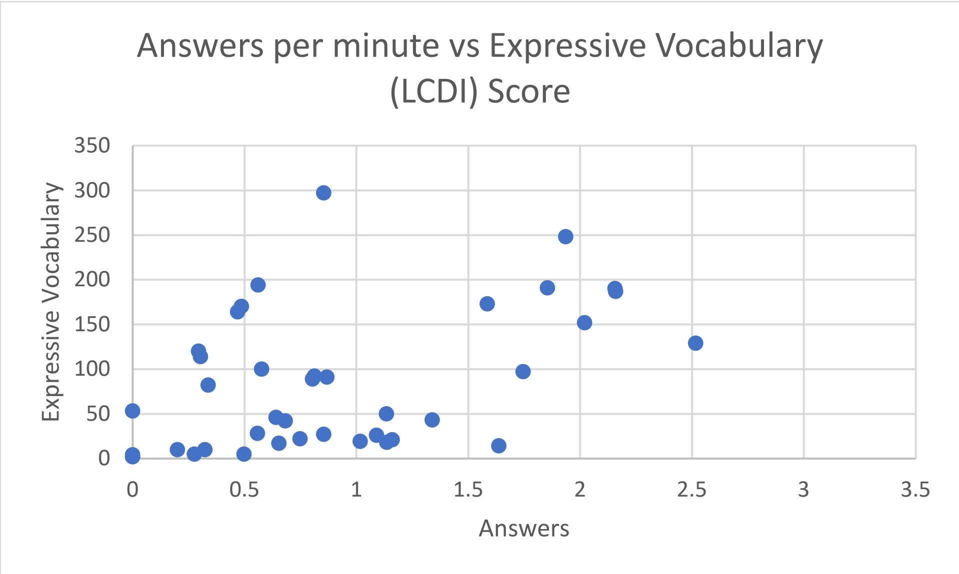


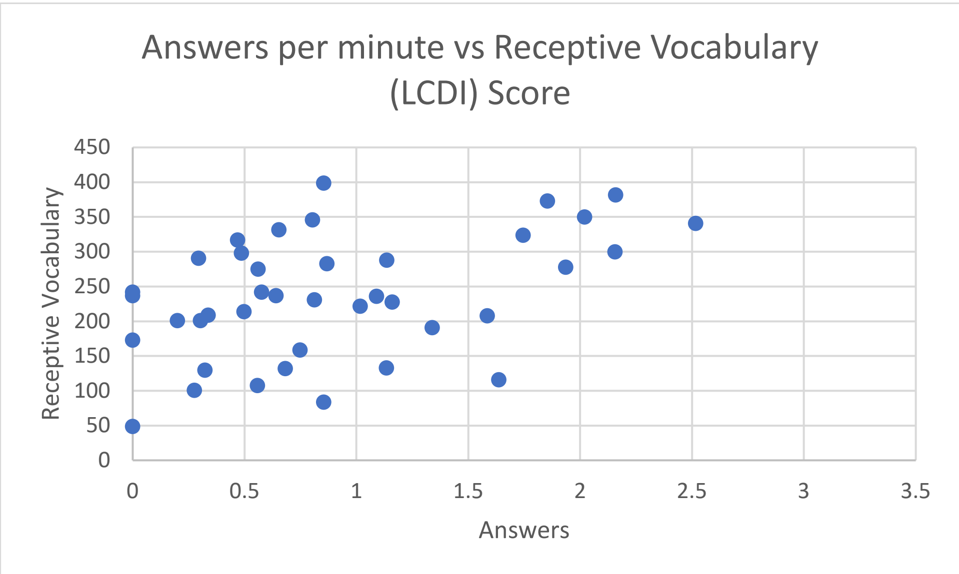




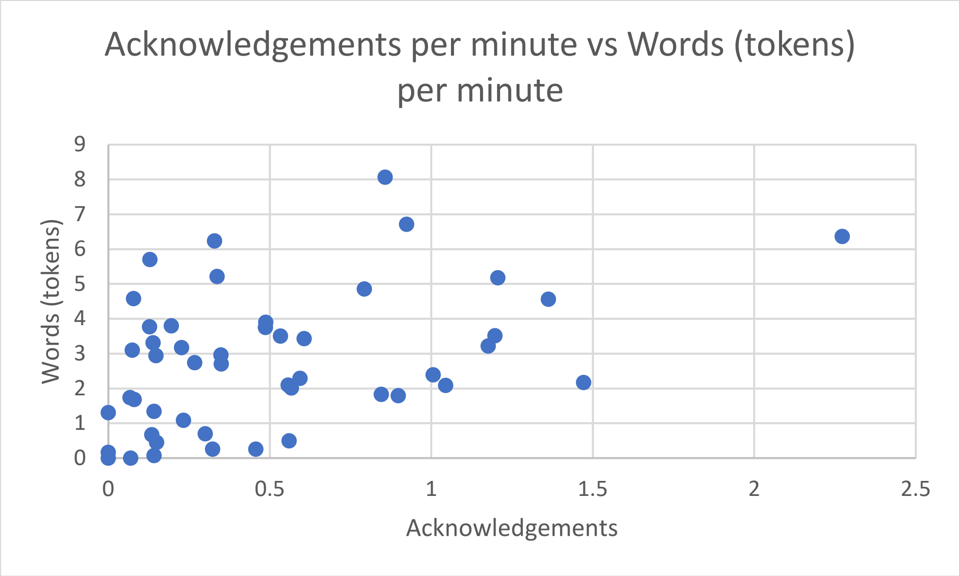
Appendix D: Scatterplots for Relationships Between Variables in Chapter 3

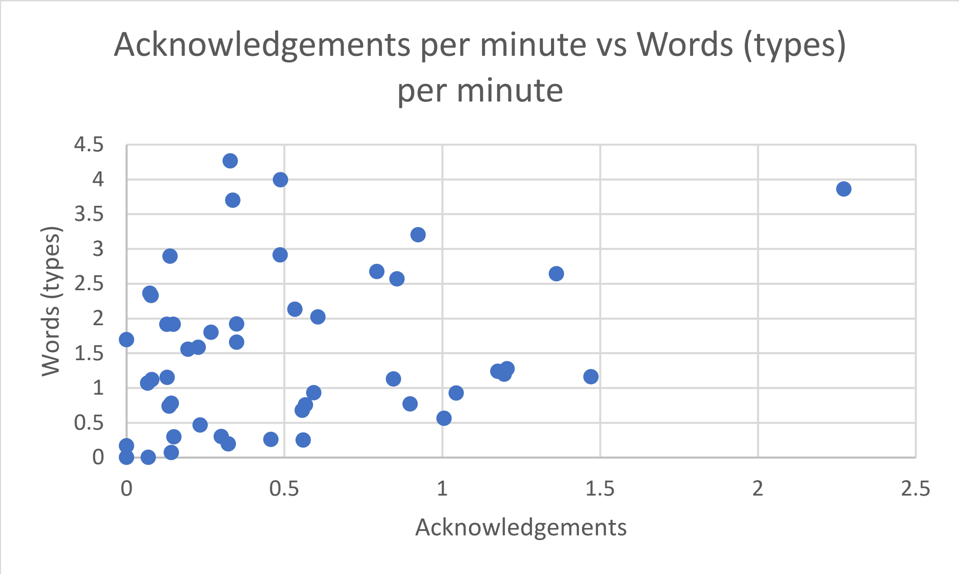


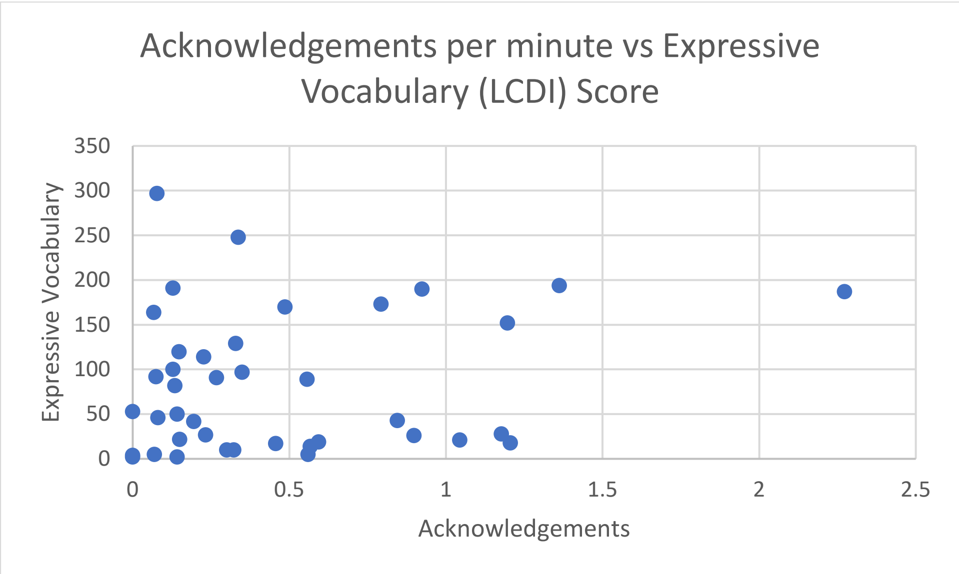




Appendix D: Scatterplots for Relationships Between Variables in Chapter 3







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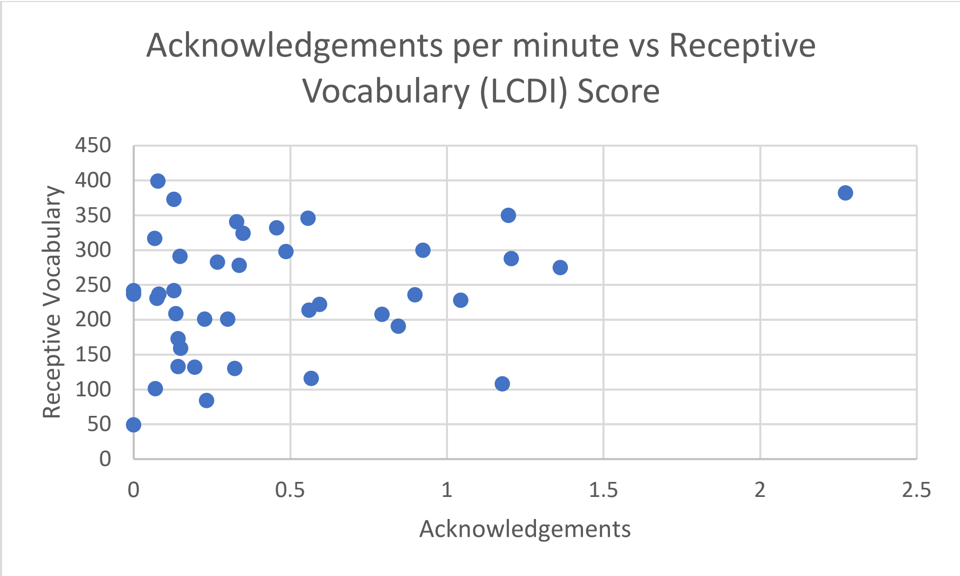
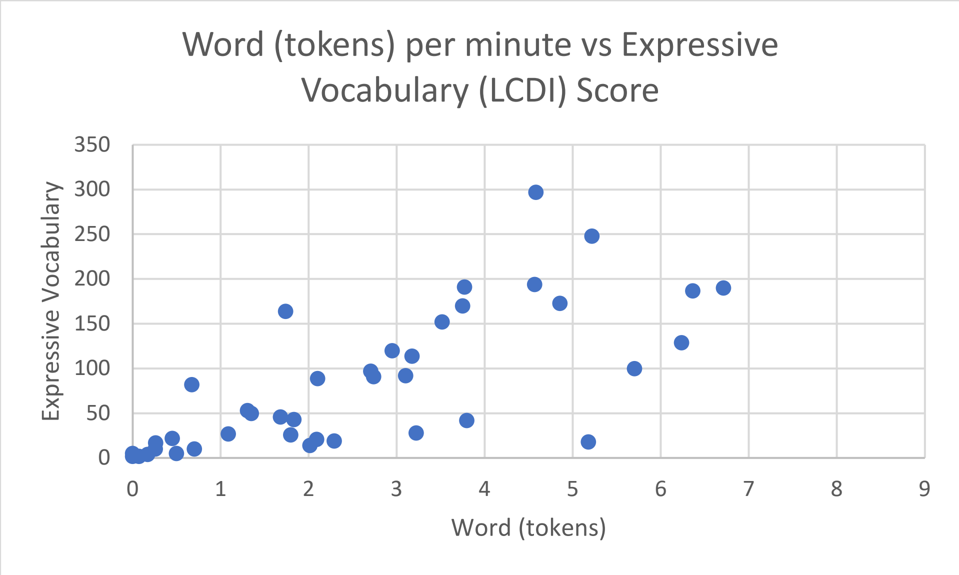
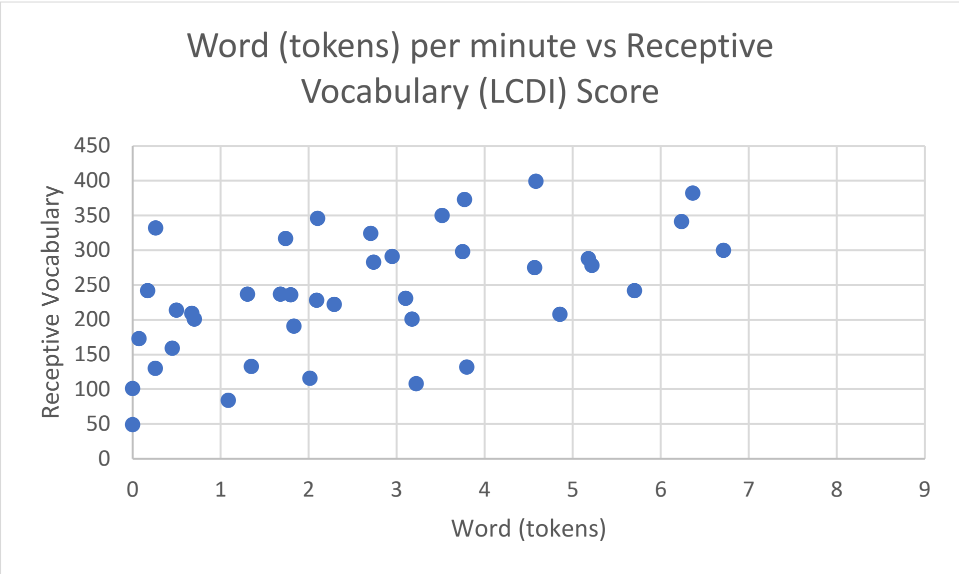
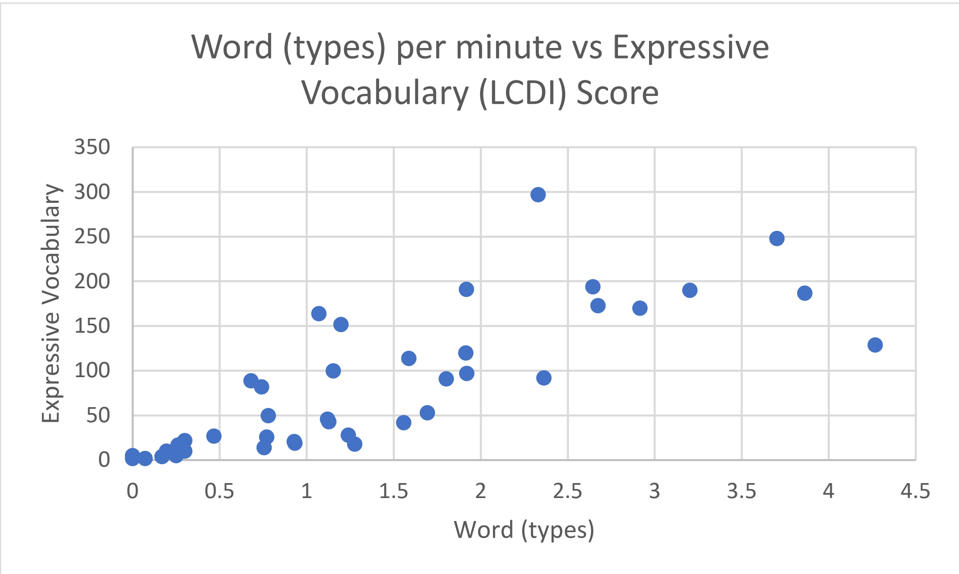


Appendix D: Scatterplots for Relationships Between Variables in Chapter 3

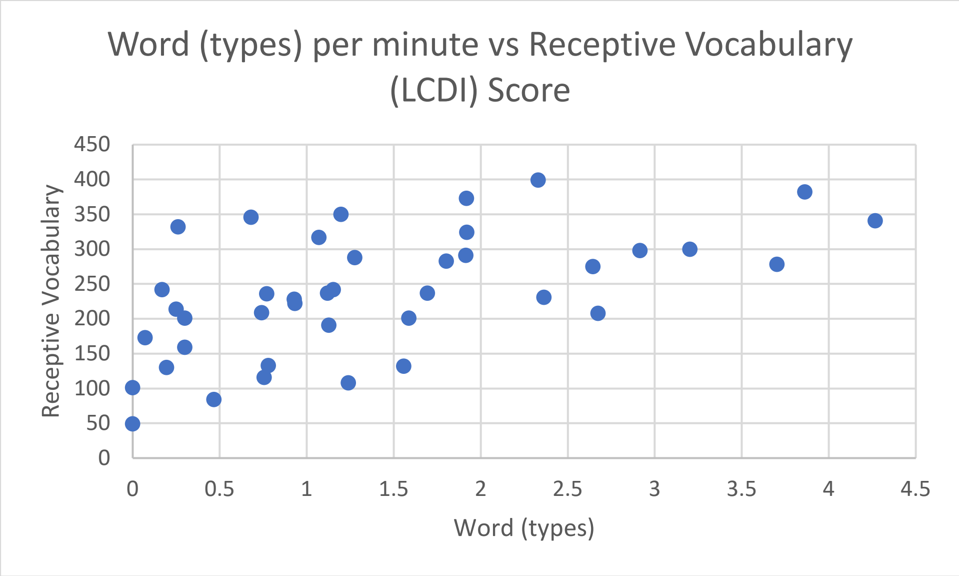
Correlations between Naturalistic and Parental Report Measures of Formal Language





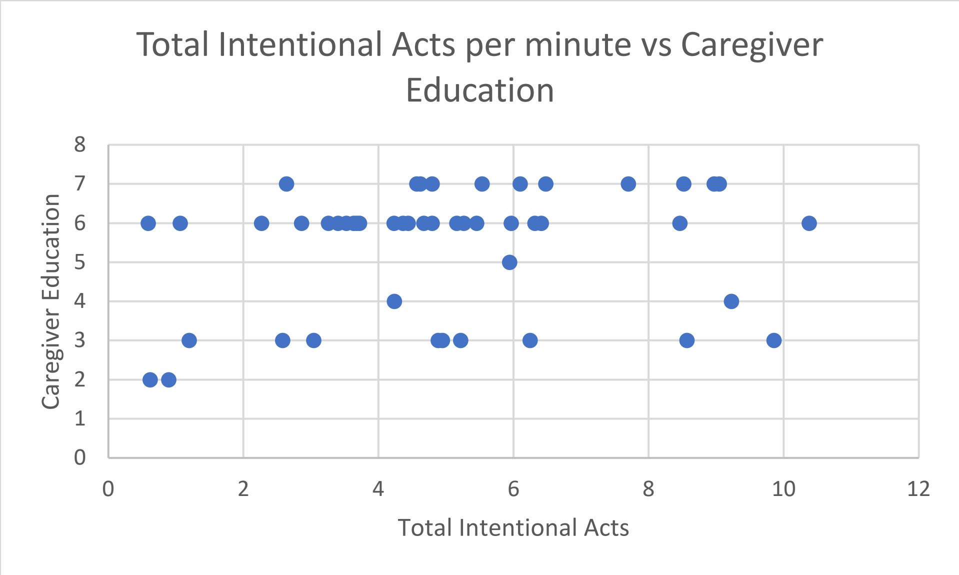


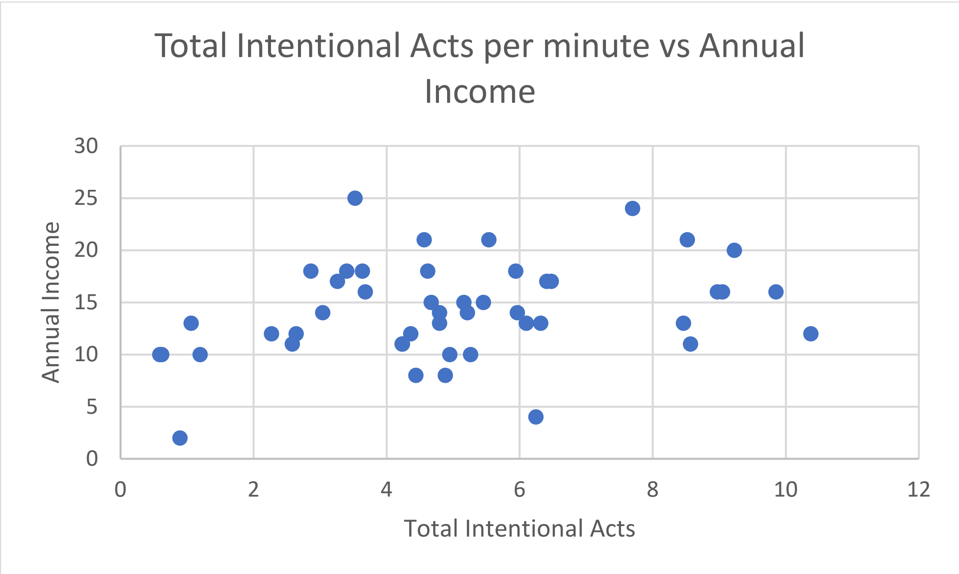
Appendix D: Scatterplots for Relationships Between Variables in Chapter 3

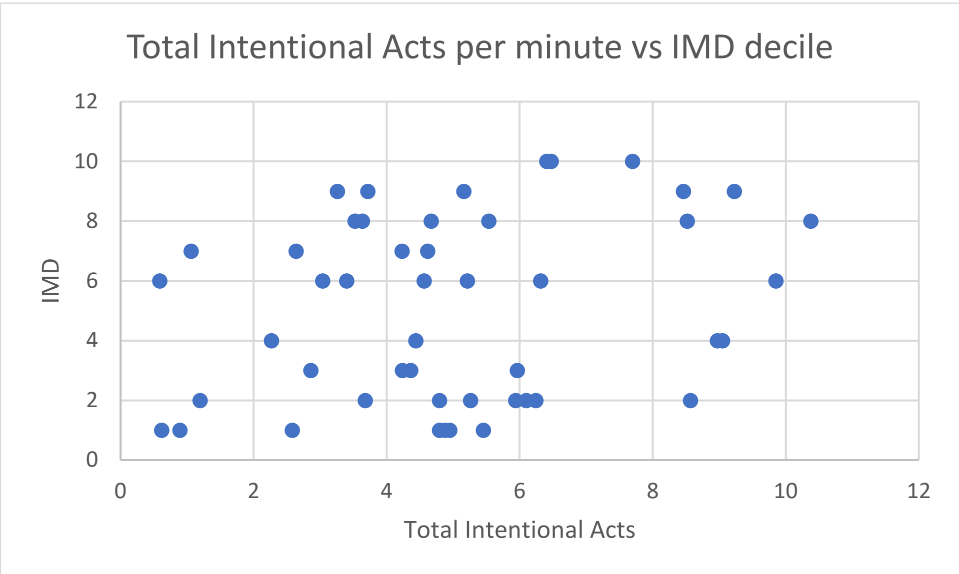


Appendix E: Scatterplots for Relationships Between Variables in Chapter 3

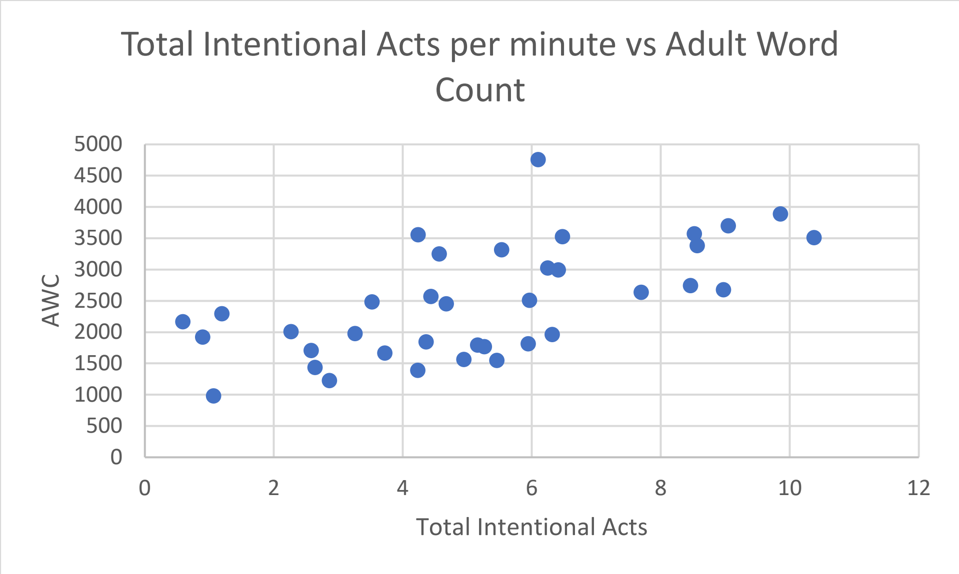
Correlations Between SES Indicators and Communicative Intentions (Control Group)

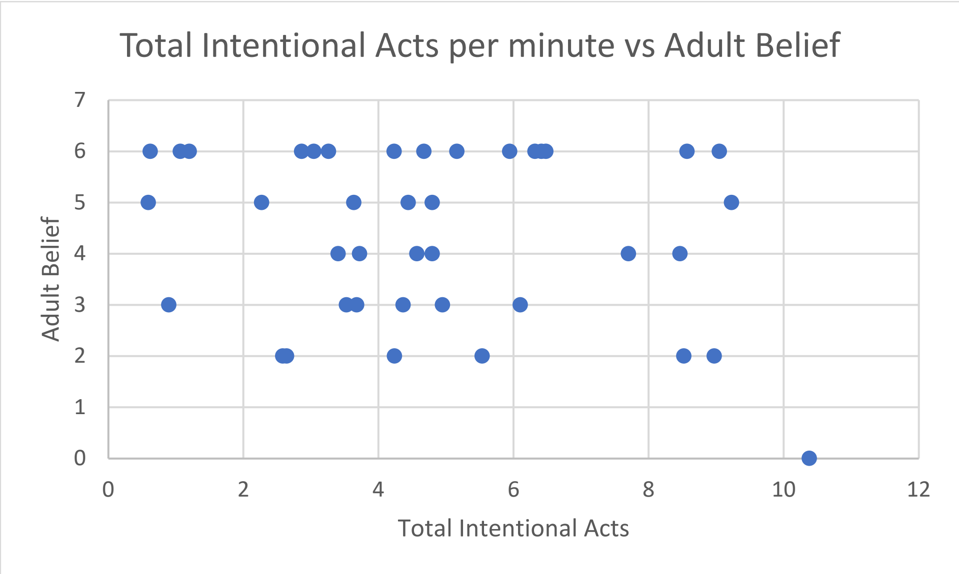


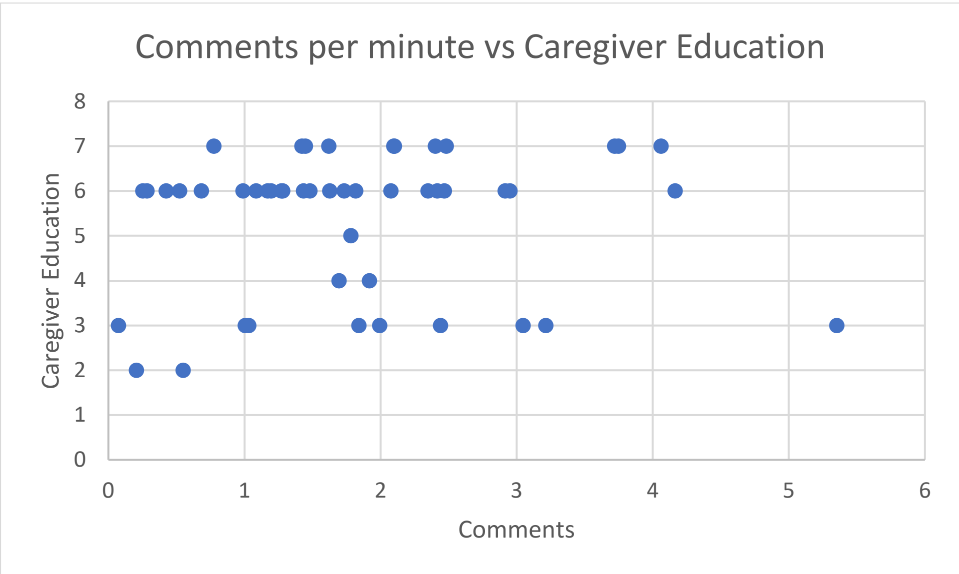




Appendix E: Scatterplots for Relationships Between Variables in Chapter 3







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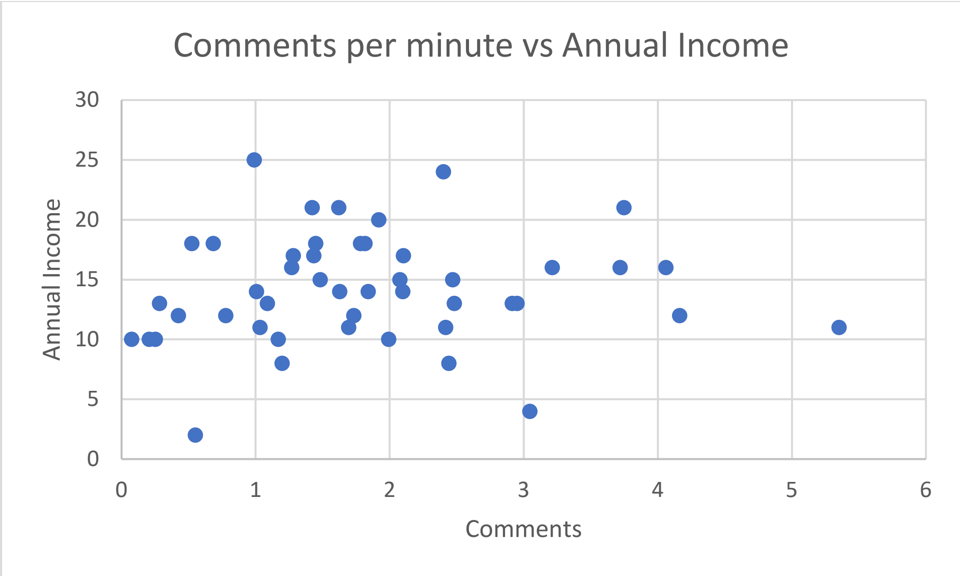

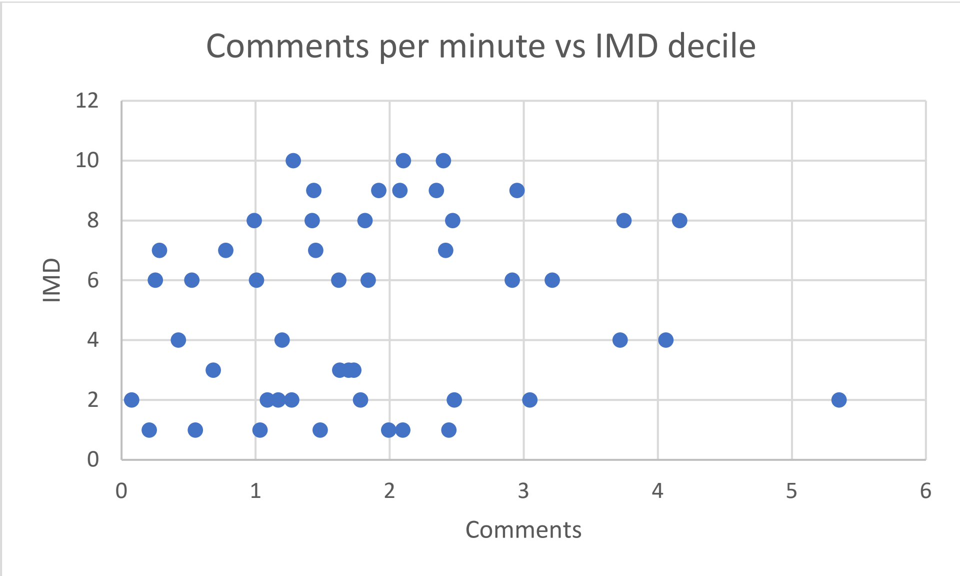

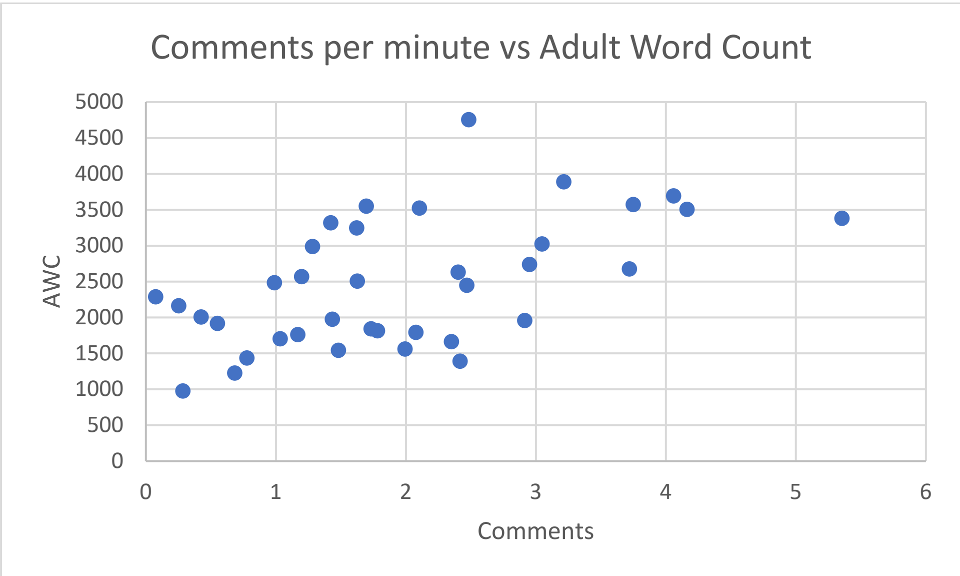

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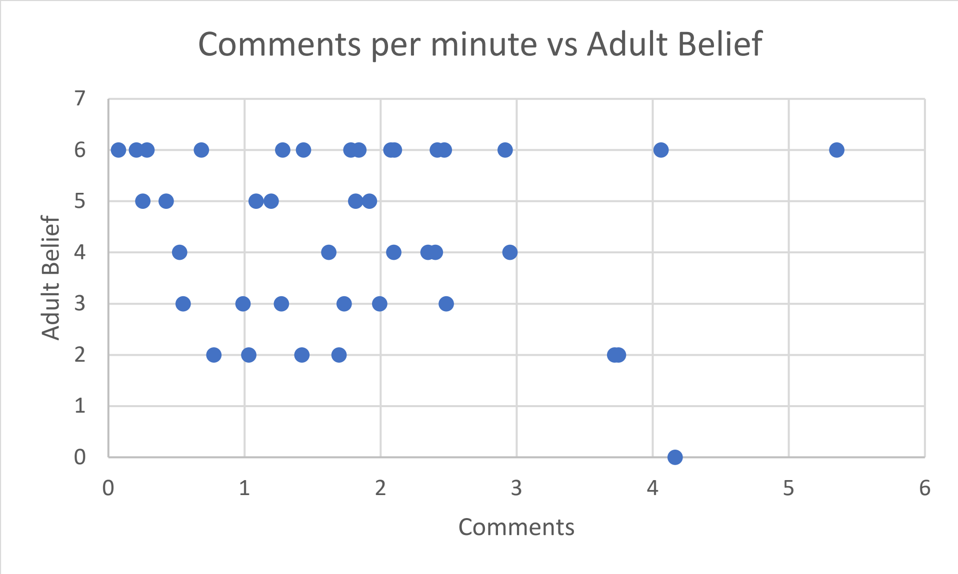

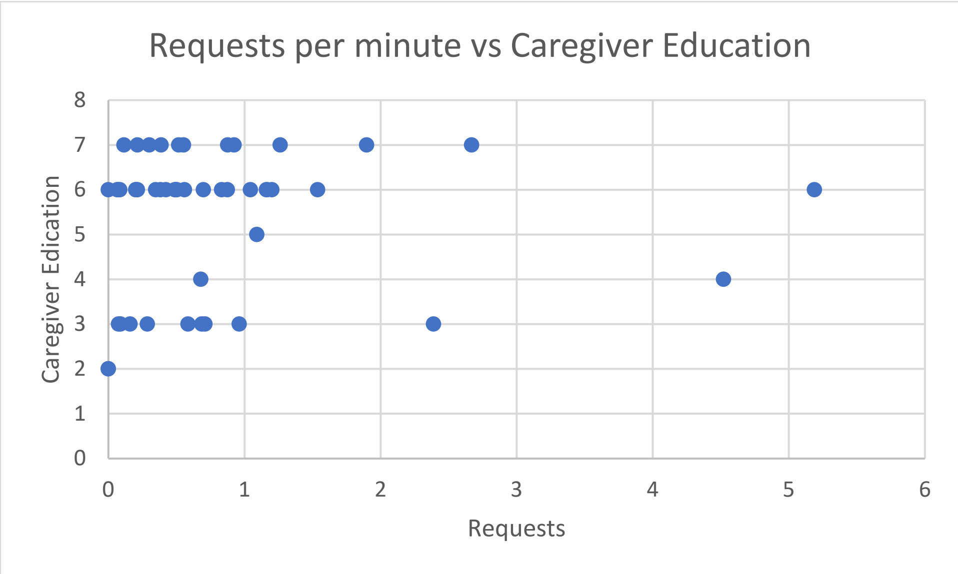

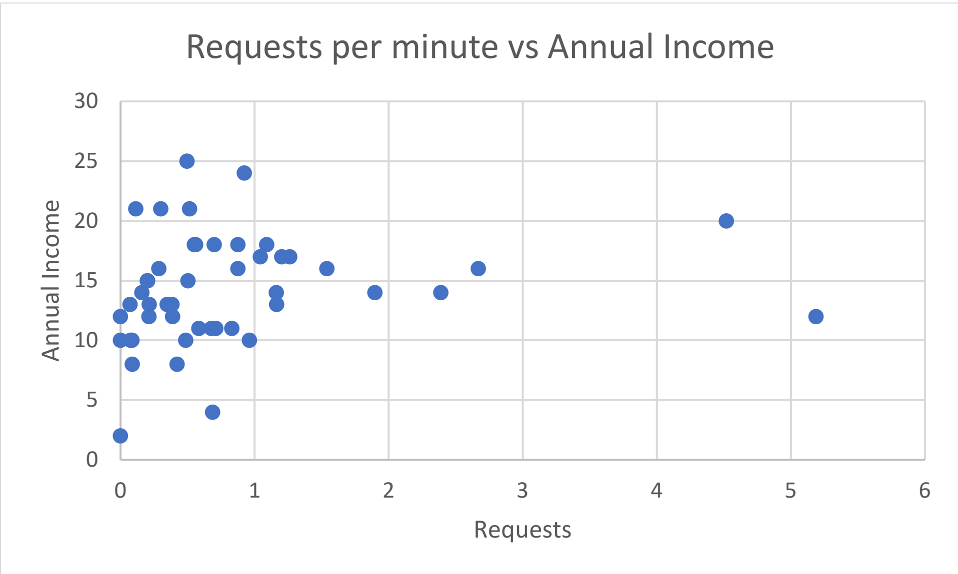

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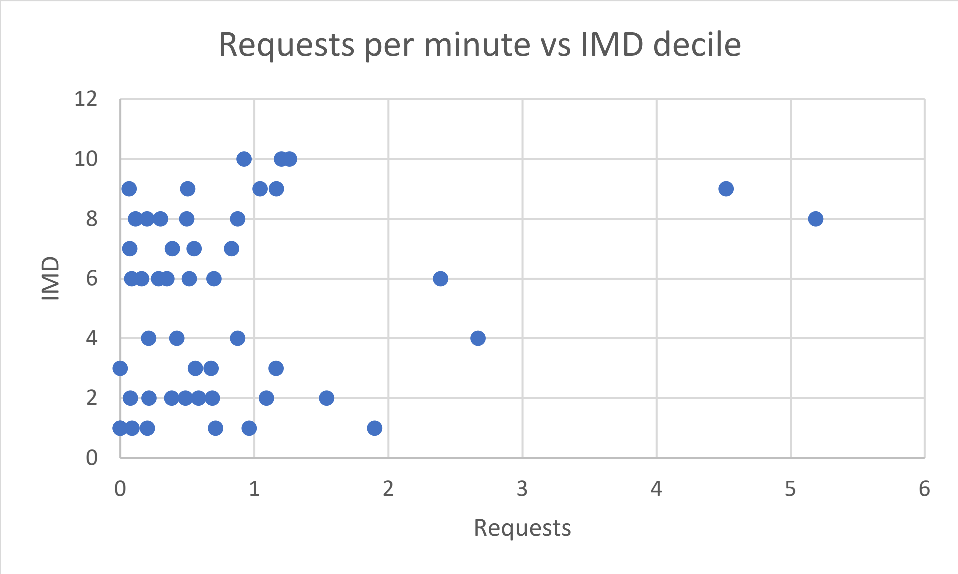

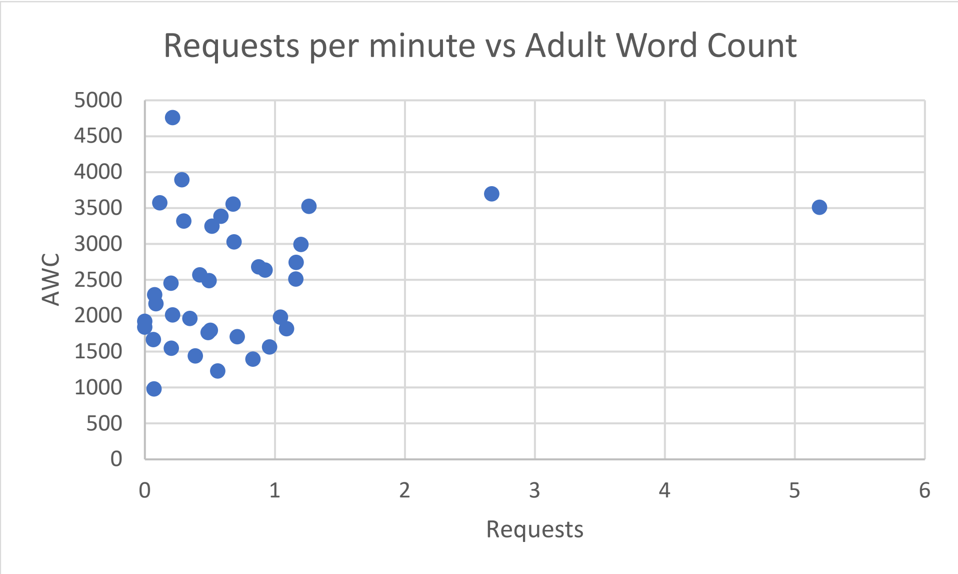

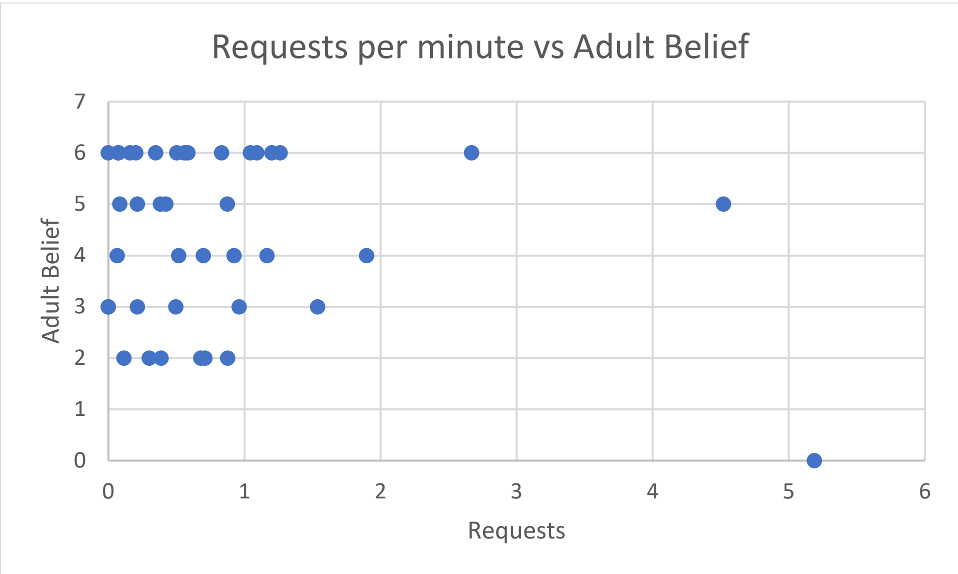

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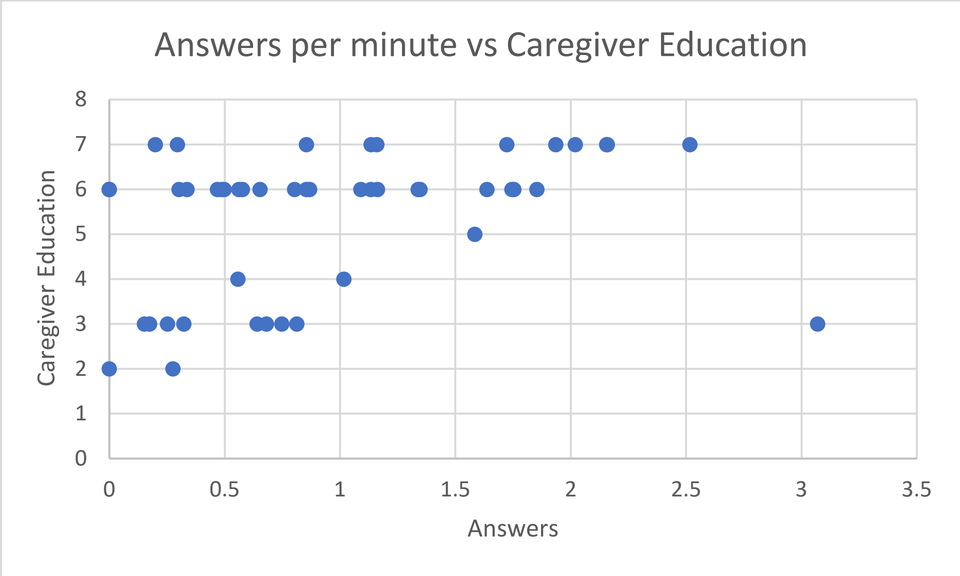

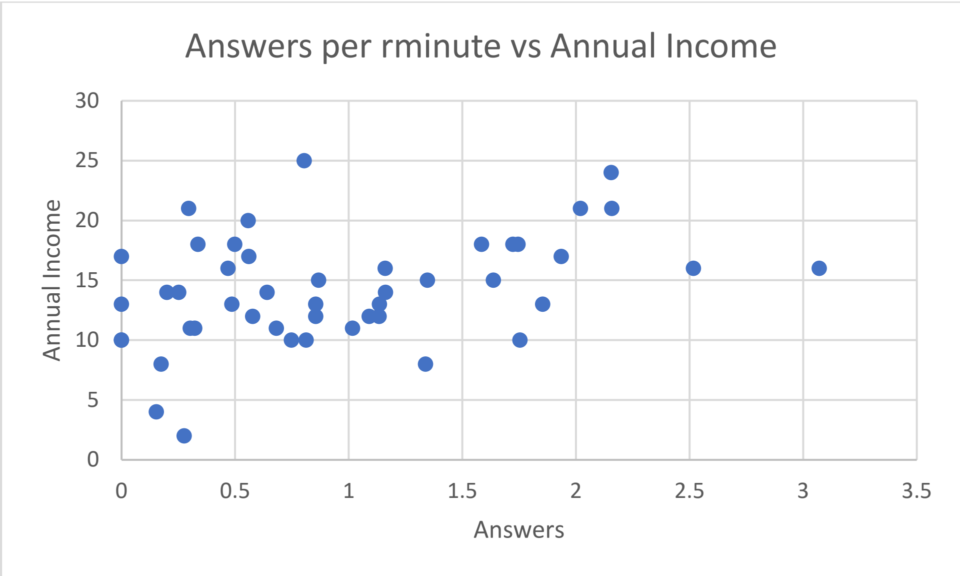

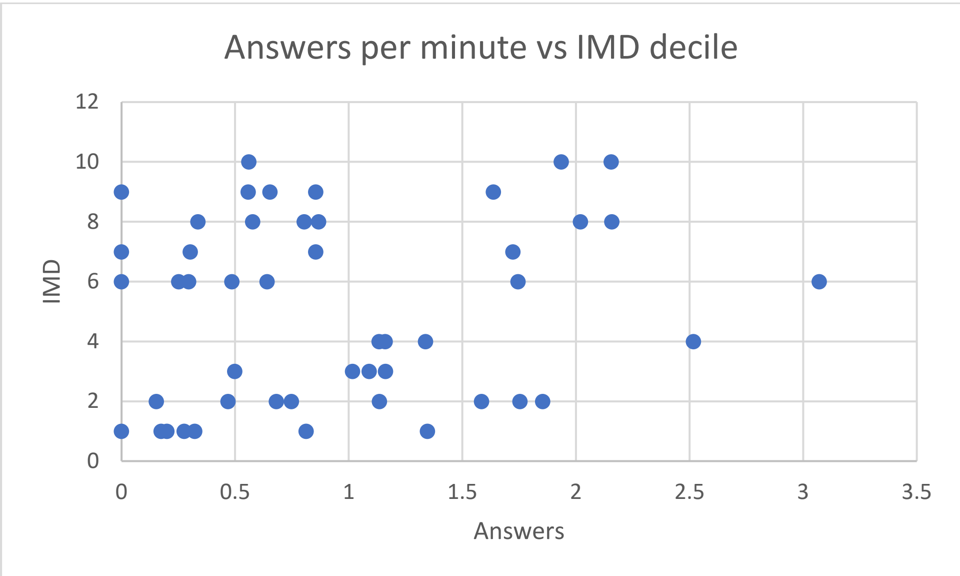

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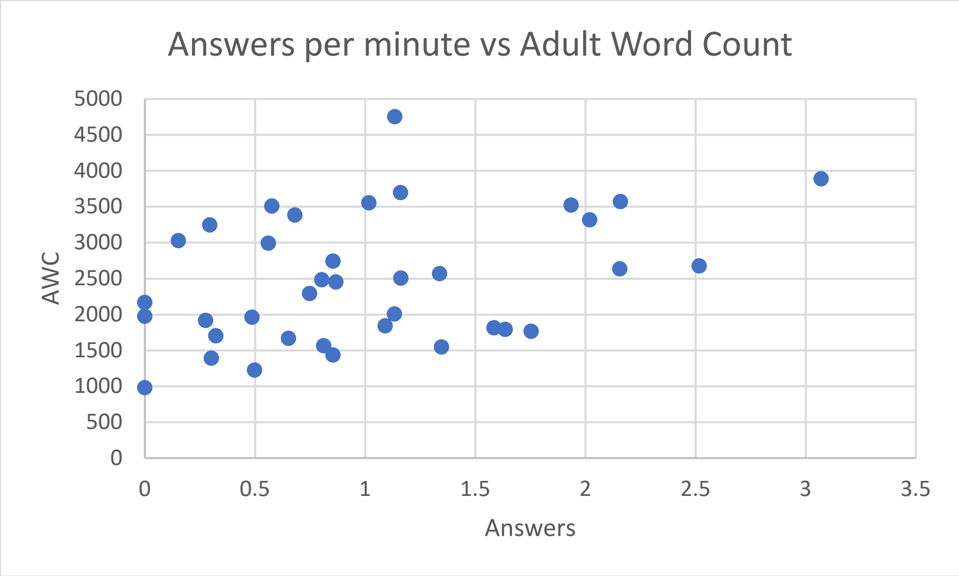

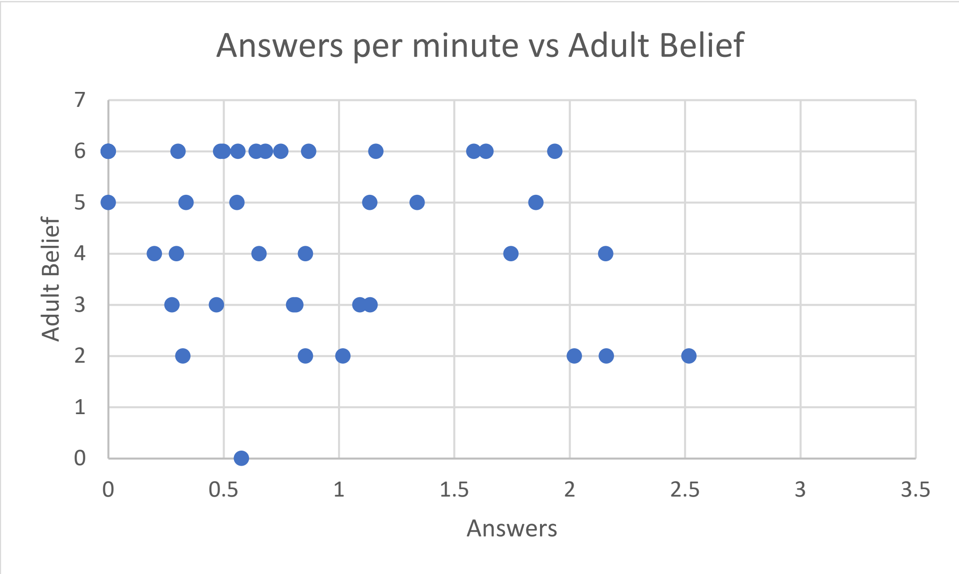

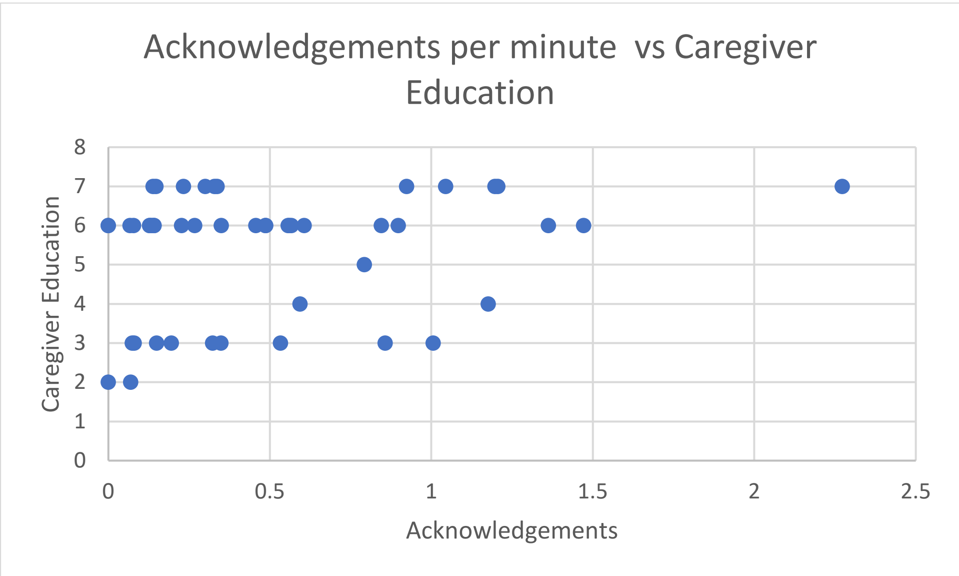

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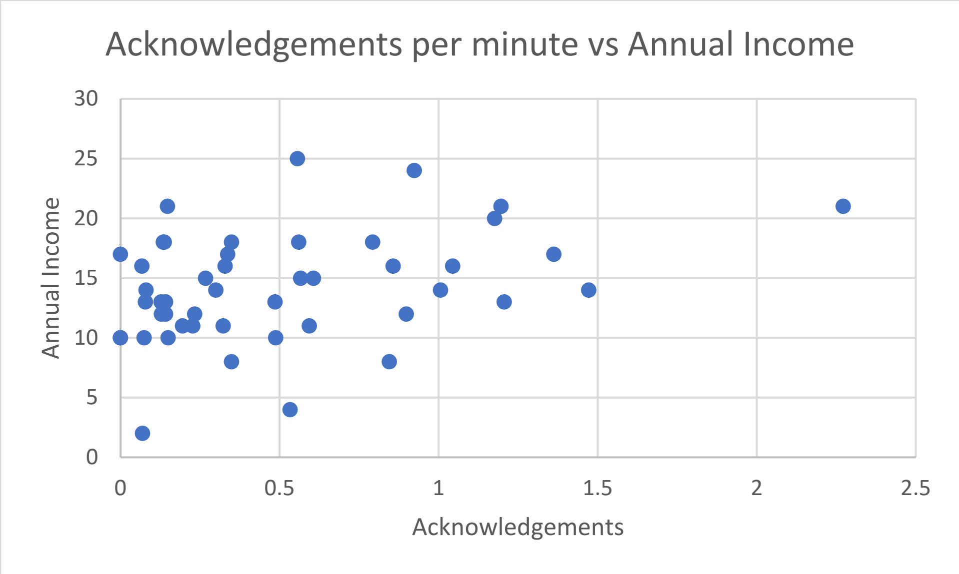

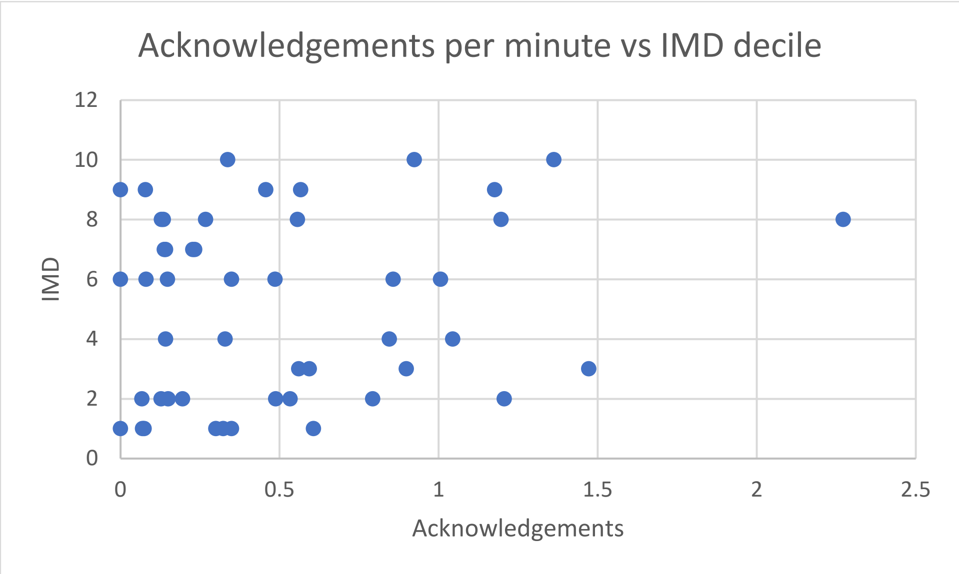

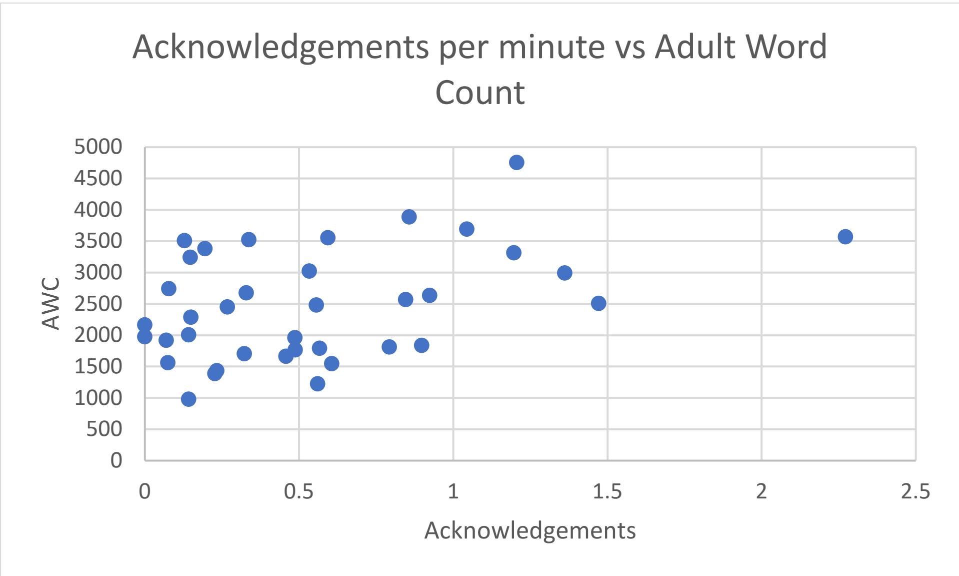

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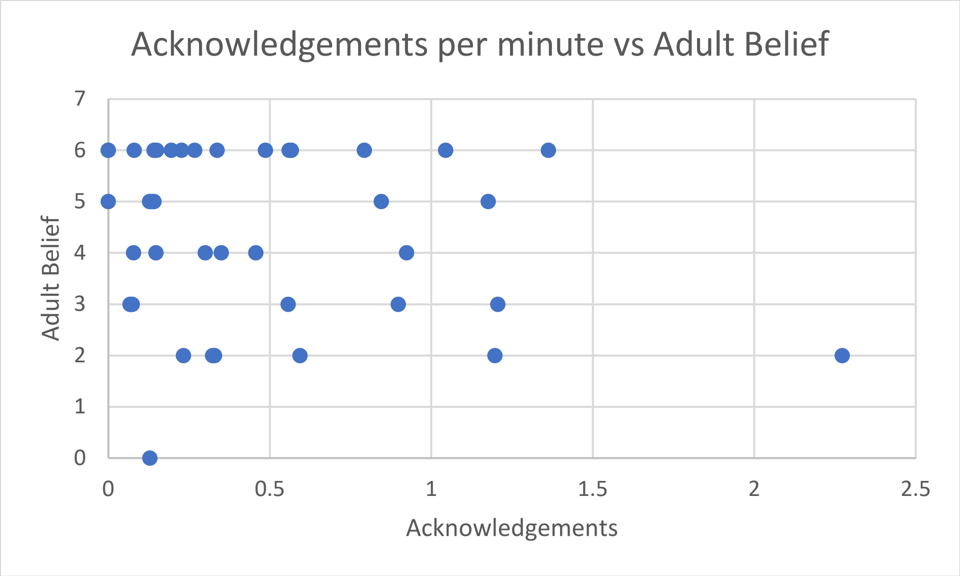
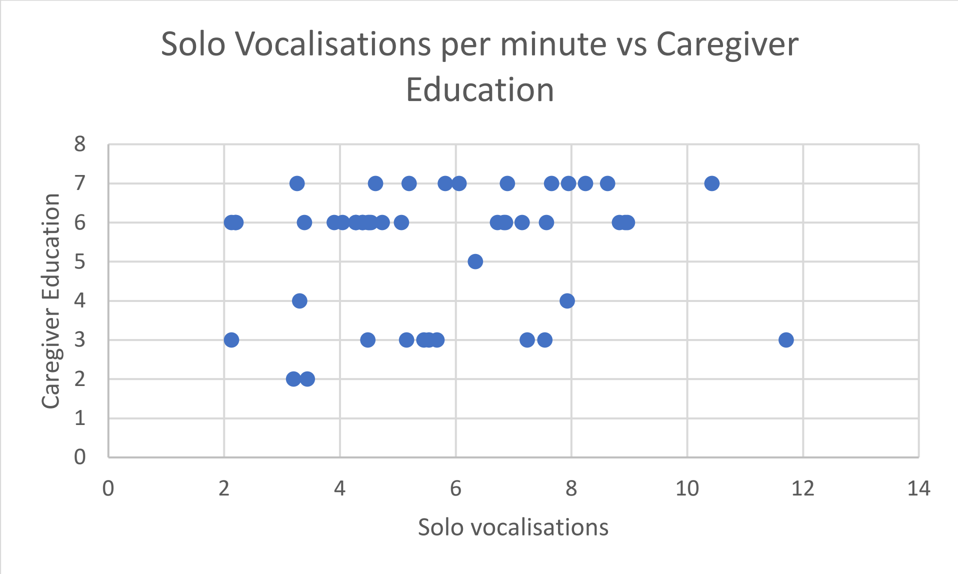
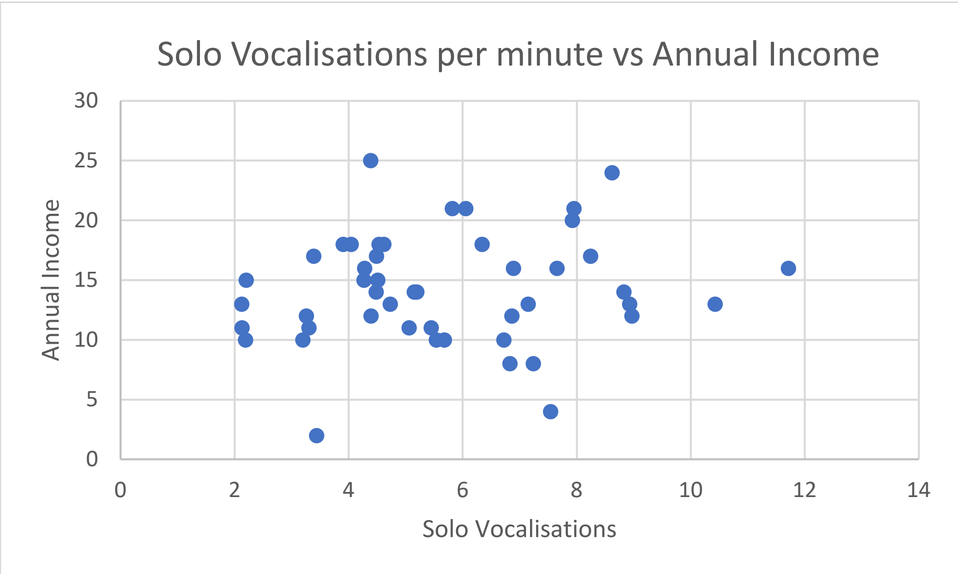


Appendix E: Scatterplots for Relationships Between Variables in Chapter 3

Correlations Between SES Indicators and Modality (Control Group)





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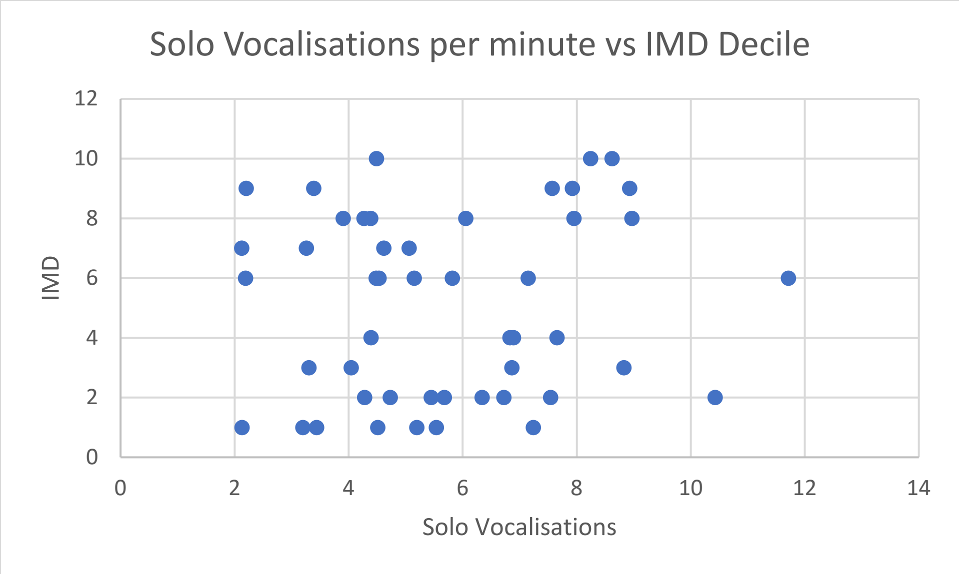

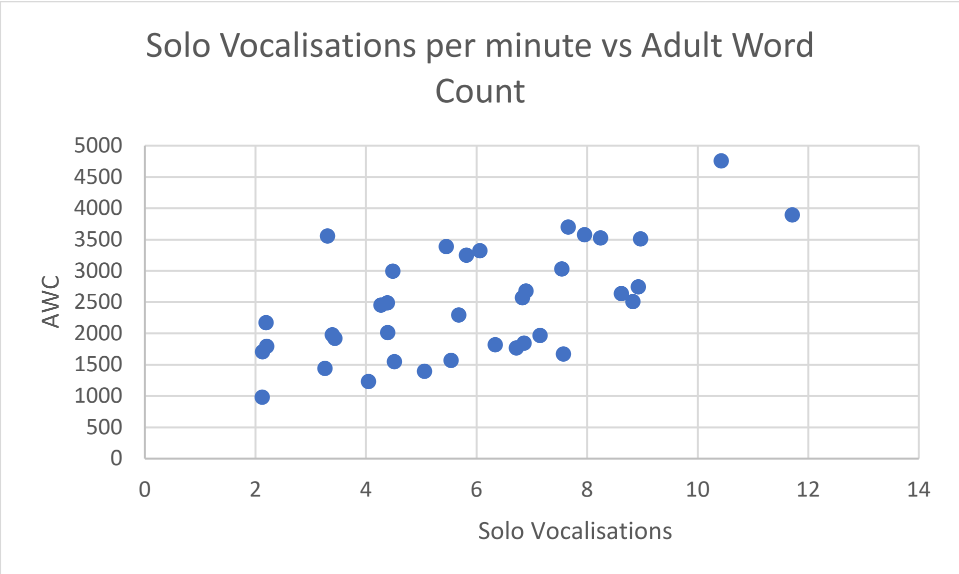

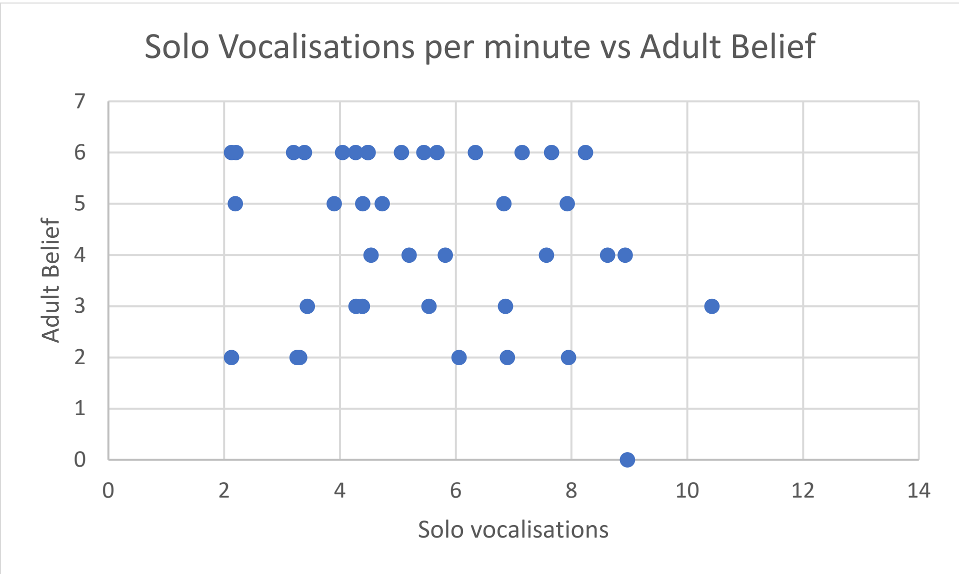

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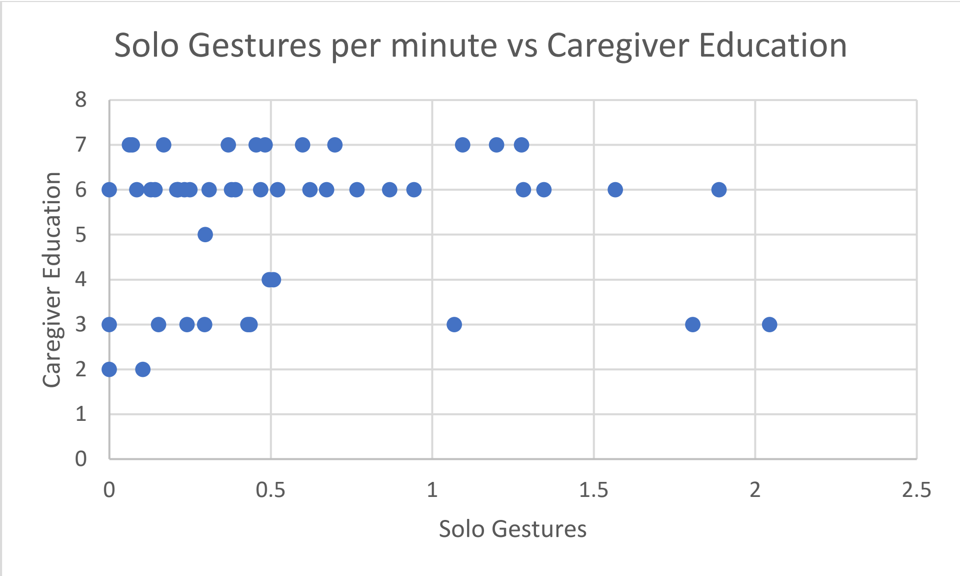

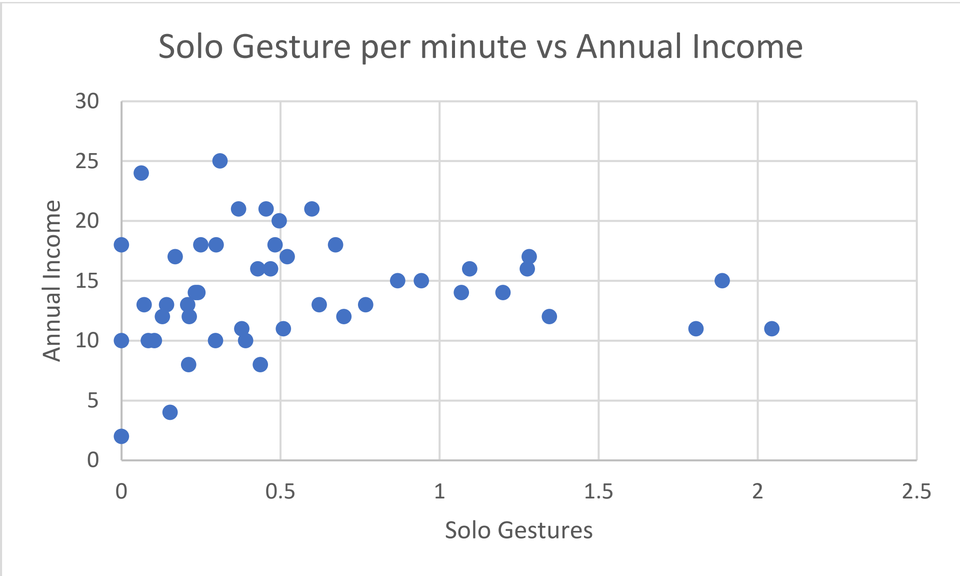

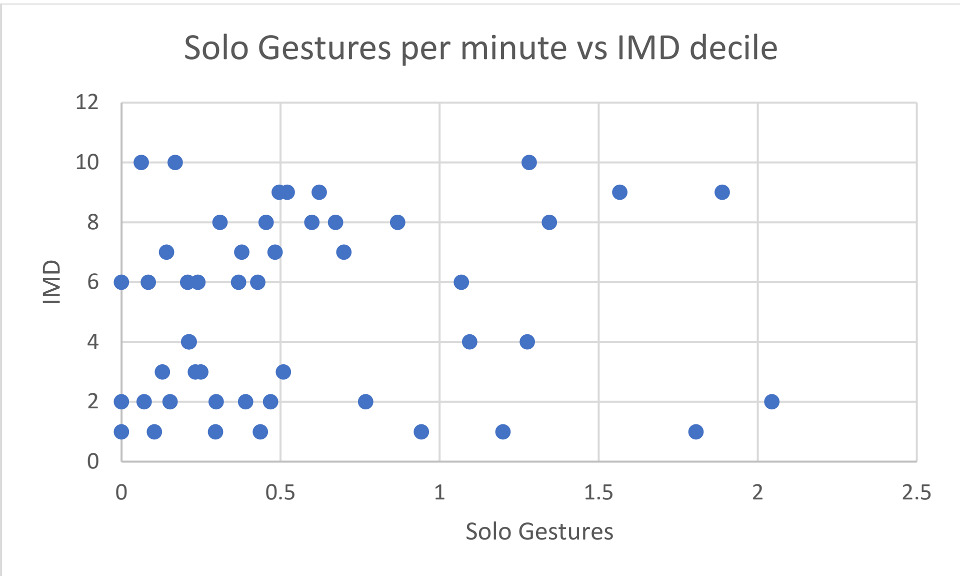

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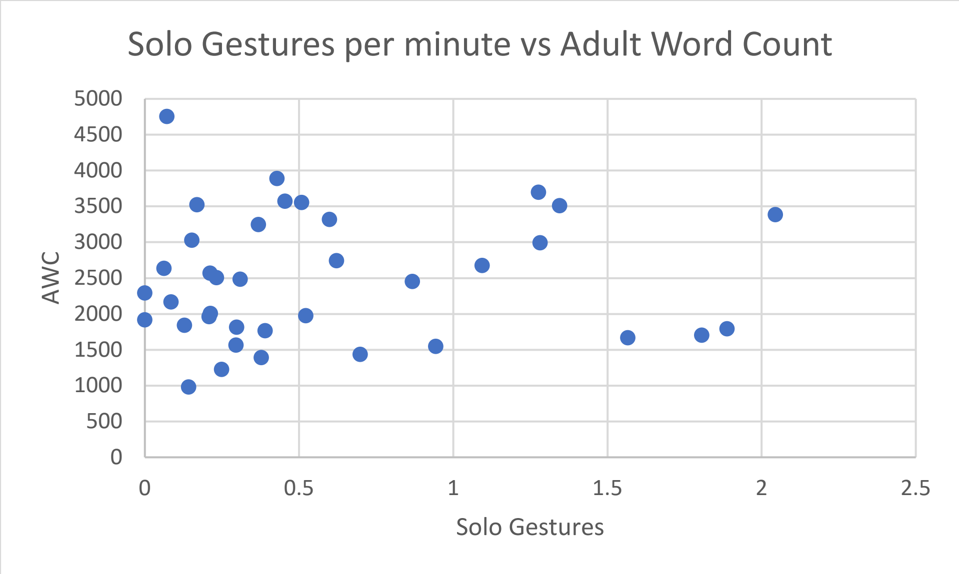

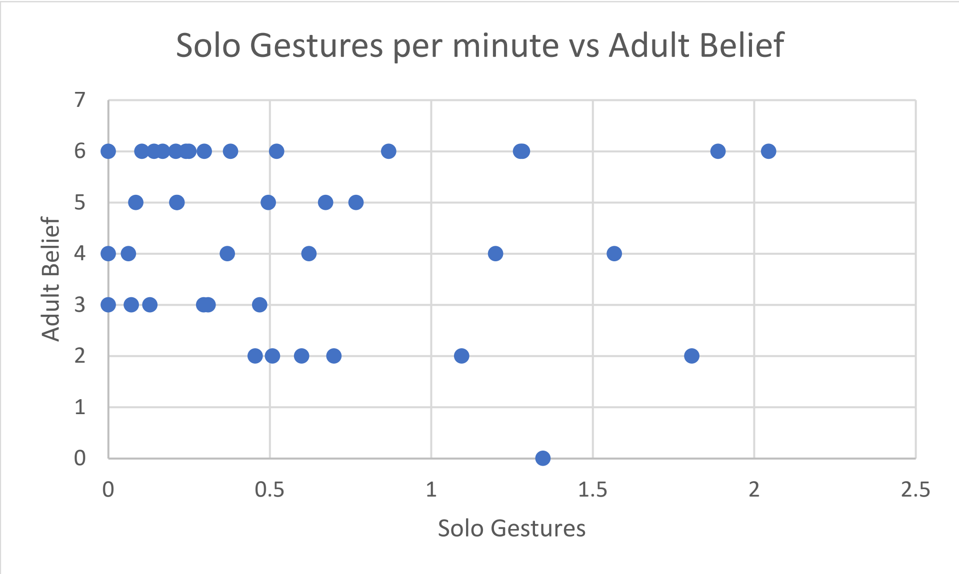

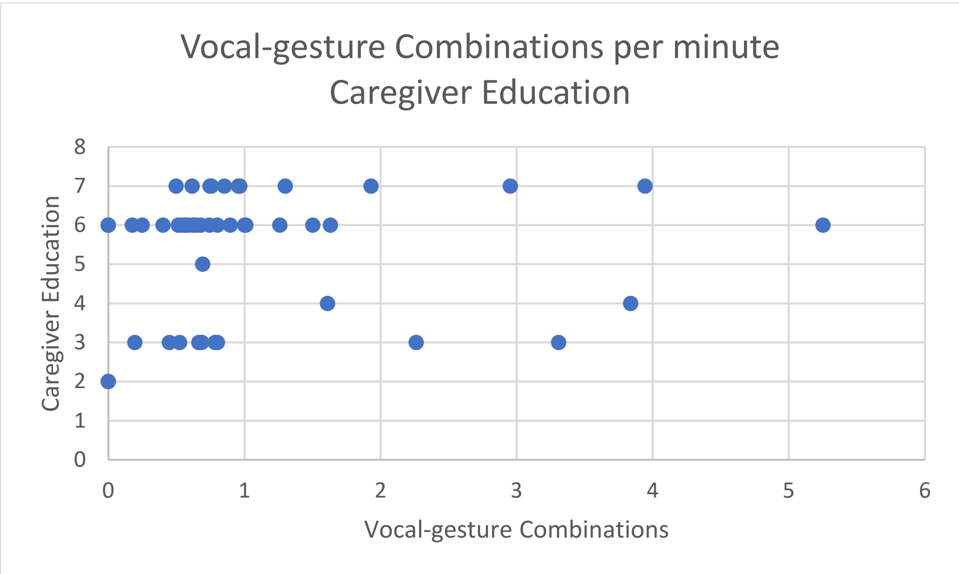

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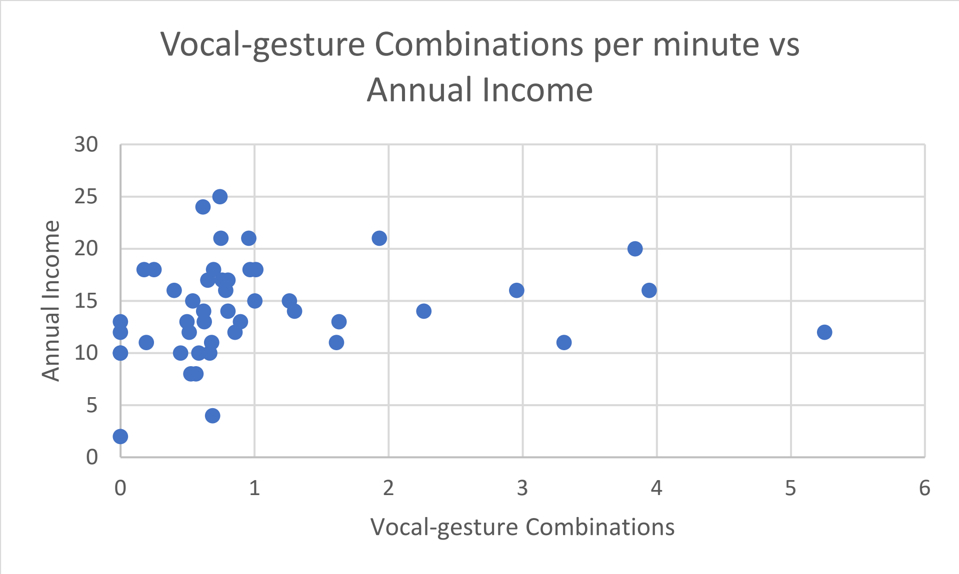

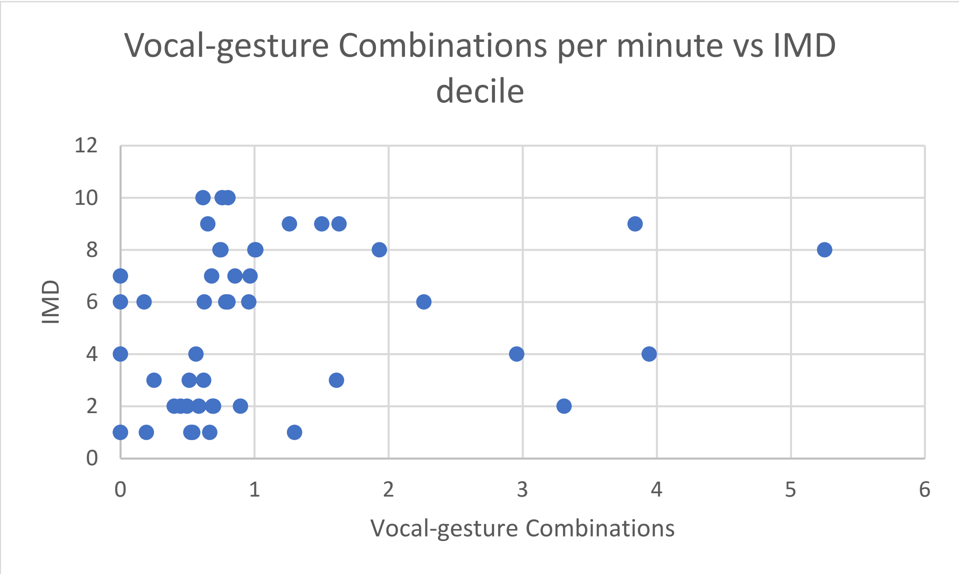

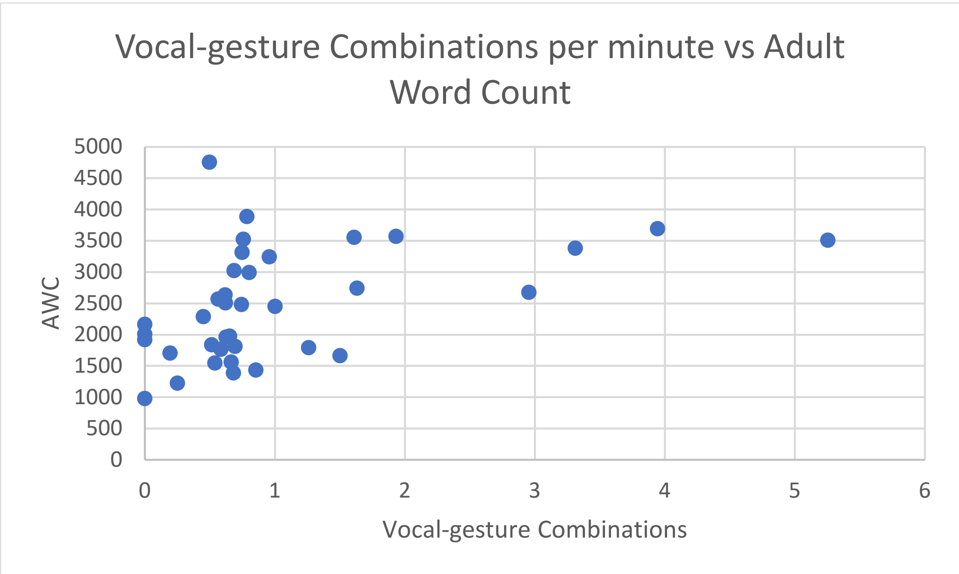

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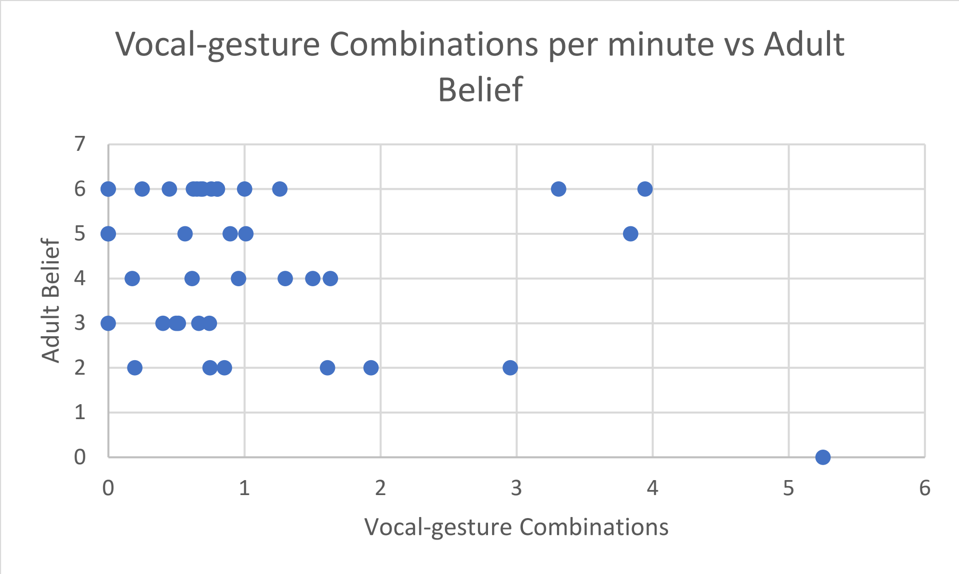

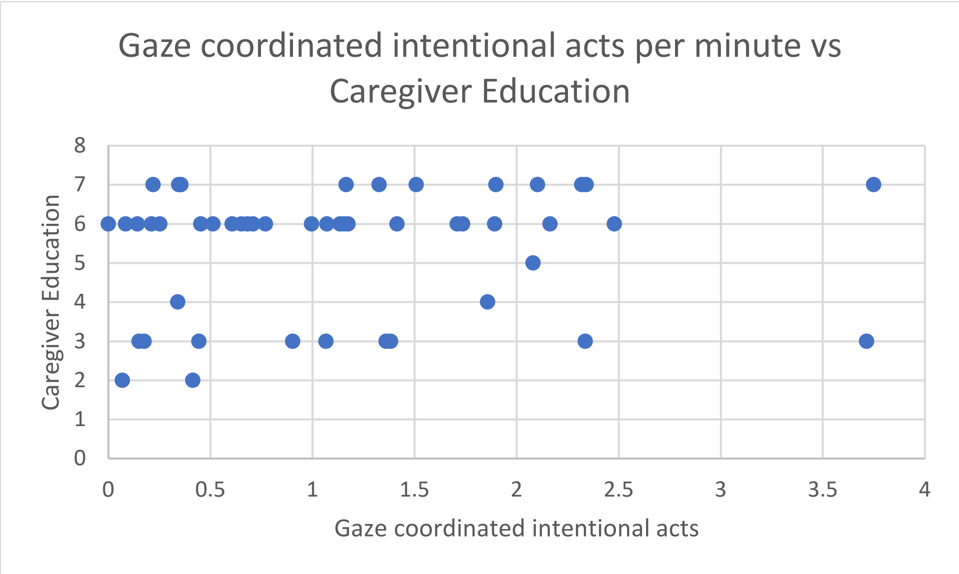

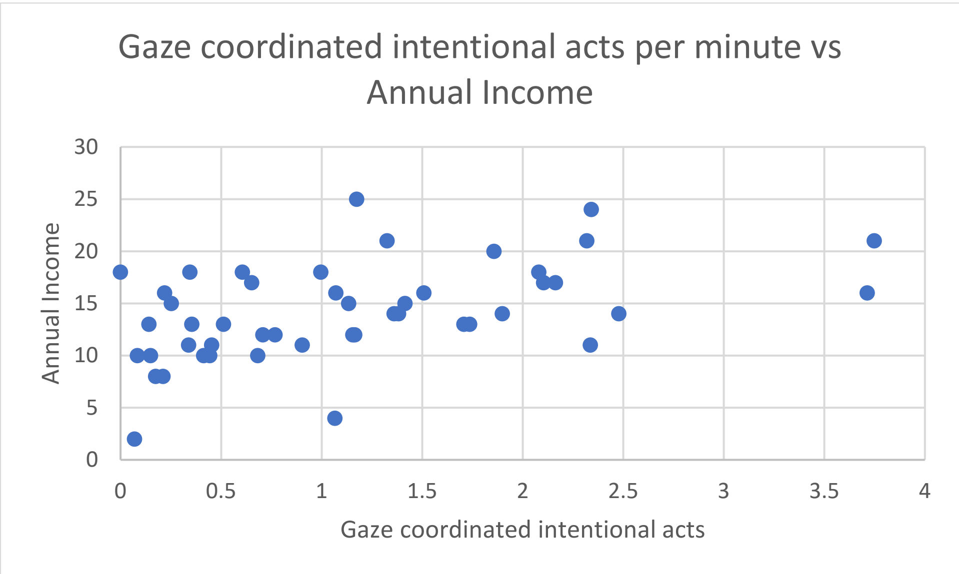

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