The Role of the Verbal Code in Visual Memory

Sumyah Abdullah Ibrahim Alnajashi

Submitted in accordance with the requirements for the degree of

Doctor of Philosophy

The University of Leeds

Institute of Psychological Sciences

May, 2013

Acknowledgements

This body of work is not only the fruit of my efforts but is also borne out under the supervision of Dr. Charity Brown and Dr. Richard Allen. To me, their comments were always like treasures which I kept in safe folders and checked from time to time. Their sugar coated feedback guided me through fuzzy periods. They deserve to be deeply thanked for their dedicated and continued supervision. My thanks, also, go to Prof. Mark Mon-Williams for his help and advice.

The words cannot escape my heavy precious message anymore. That is my flooded thanks to my cherish parents. To me their words push the glucose to my mind. Their sunny faces were just what I wanted to see every morning. They are the warm side I rest on. I feel drowned by their favours. My Mum's nice food built my cells and my dad's time searching for visual equipment, examining and fixing them is shining on every single word I read. Their long journeys from Saudi Arabia to the UK for nothing other than to offer me support, are tremendously huge in contrast to my dwarf letters of thanks. Mum and Dad this thesis is dedicated to you.

From the bottom of my heart, I want to thank my brother 'Mohammed' who was the reason for my sigh of relief whenever I felt homesick and no other member of my family was around, his long journeys by train to complete my forms or to meet me at the airport, scratching his head before fixing my equipment or to solve unforeseen problems. He also brought the CDs I wanted or the food that I like as a surprise, and all bring memories that are conditioned with sincere smiling thanks. My thanks also go to my very own sister 'Alaa' who joined me in my last year in Leeds. She changed our house and brought it to life; made everything convenient, and made my needs seem so much smaller through her support. She is the blessing who I had missed for several years whilst studying here in England.

Inspiration came to me from my sister ‘Dr. Hind’, who always preceded me in her academic achievements. It is as if she were saying: ‘We inherited similar genes. You can do it as well’. Muaath is always my role model of a young brilliant researcher, Rawan by her practicality and enthusiasm tells my dimmed moments to go away, and Arwa, who listens carefully with empathy to my issues and gives wise suggestions, has put the sugar on my soul.

Another person, who was always in the background of my story, is my best friend, my intermediate school English teacher, whom I still call ‘Teacher Maysa’. She pushes me to do, lives with me moment by moment and then makes me feel overwhelmed by the results. Neveen my lovely sweetie friend is also to be sincerely thanked. Four years ago, I knew her in York. She never stopped offering kind help. She is the most loyal, faithful friend ever.

Other people to thank are: Emma Portch, who collected data from 15 participants for my research, friends in York and Leeds, who were reassuring and extremely helpful, especially in recruiting participants for my research, and all the participants, who were willing to come and take part in my experiments. Indeed, recruiting such a massive number of participants was a nightmare.

Abstract

This thesis uses visual imagery tasks (mental rotation and mental subtraction) to examine verbal interference and verbal facilitation in visual memory. It demonstrates how task demands can mediate the verbal interference and verbal facilitation effects in visual imagery. Using the mental rotation paradigm, this thesis places a focus upon the method of stimulus presentation during the learning phase and the test. It demonstrates how a presentation method that emphasizes serial order (the temporal presentation method) can elicit positive effects of covert spontaneous naming during both encoding and retrieval. In contrast, a presentation method that emphasizes spatial information does not show a significant role for covert spontaneous naming during encoding or retrieval. Further, under temporal presentation conditions, explicit labelling during encoding (via the use of either self-generated or experimenter-generated labels) is found to show an interfering effect compared to covert spontaneous naming. Using experimenter-generated labels, it is found that re-presenting the explicit verbal labels as cues at retrieval removes the interfering effects of explicit labelling during encoding and enhances performance. In addition, reducing exposure to explicit verbal labels during encoding is found to be a possible method for removing the negative effect of explicit verbal labels during encoding. Finally, the positive effect of covert spontaneous naming and the negative effect of explicit labelling are replicated using a different mental subtraction paradigm. Overall, the findings indicate that task demands determine the role of the verbal code in visual imagery. Hence, there is no unified theory to account for the role of the verbal code in visual memory, but different theories can be applied under different conditions.

Table of Contents

List of Figures

List of Tables

Chapter 1: General Introduction

The role of verbalization has been studied in a wide range of cognitive domains, including visual memory (e.g., Brandimonte, Hitch & Bishop, 1992a; Schooler & Engstler-Schooler, 1990), musical memory (e.g., Perfect, Hunt & Harris, 2002), wine tasting (e.g., Melcher & Schooler, 1996), spatial memory (e.g., Fiore & Schooler, 2002), decision making (e.g., Wilson & Schooler, 1991), insight problem solving (e.g., Schooler, Ohlsson & Brooks, 1993), visual reasoning (e.g., DeShon, Chan & Weissbein, 1995), and analogical transfer (e.g., Sieck, Quinn & Schooler, 1999). One substantial focus of research has been on the role of verbalization in visual memory, including face recognition (e.g., Brown & Lloyd-Jones, 2002; 2003; 2005; 2006; Dodson, Johnson & Schooler, 1997; Fallshore & Schooler, 1995; Finger, 2002; Hunt & Carroll, 2008; Kitagami, Sato & Yoshikawa, 2002; Lloyd-Jones & Brown, 2008; Lloyd-Jones, Brown & Clark, 2006; MacLin, Tapscott & Malpass, 2002; MacLin, 2002; Meissner, 2002; Melcher & Schooler, 2004; Schooler & Engstler-Schooler, 1990), picture recognition (e.g., Daniel & Togila, 1976; Ellis, 1968; Nakabayashi, Burton, Brandimonte & Lloyd-Jones, 2011; Nelson & Kosslyn, 1976; Verhaeghen, Palfai & Johnson, 2006), and visual imagery (e.g., Brandimonte et al., 1992a; Brandimonte, Hitch & Bishop, 1992b; Brandimonte & Gerbino, 1993; Brandimonte, Schooler & Gabbino, 1997; Brandimonte & Collina, 2008; Pelizzon, Brandimonte & Favretto, 1999; Pelizzon, Brandimonte & Luccio, 2002). Research on verbalization in visual memory has shown a verbal interference effect, whereby visual memory is impaired after verbalization (e.g., Brandimonte et al., 1992a; 1992b; Brandimonte et al., 1997; Brandimonte & Collina, 2008; Brown & Lloyd-Jones, 2003; Dodson et al., 1997; Fallshore & Schooler, 1995; Finger, 2002; MacLin et al., 2002; MacLin, 2002; Meissner, 2002; Nakabayashi et al., 2011;

Pelizzon et al., 1999; Schooler & Engstler-Schooler, 1990) as well as a verbal facilitation effect, whereby visual memory is enhanced after verbalization (e.g., Brown & Lloyd-Jones, 2005; 2006; Daniel & Toglia, 1976; Ellis, 1968; Nakabayashi & Burton, 2008; Nelson & Kosslyn, 1976; Wickham & Swift, 2006; Verhaeghen et al., 2006). This current research selected the visual imagery domain to examine the role of task demands in moderating the effect of verbalization on visual memory. Visual imagery research has shown verbal information to both interfere with and facilitate memory performance within the same paradigm (e.g., Brandimonte & Collina, 2008). Therefore, this domain may be a useful tool with which to study how task demands create the conditions under which verbal interference might arise, disappear, or be reversed. This chapter will outline the key research on the role of verbalization in the visual memory domain. It clarifies the rationale of the present thesis, its novel contributions and how it is related to previous research that has examined the role of verbalization in visual memory. Specifically, it examines how task demands allow the effects of verbal interference and verbal facilitation within mental imagery to emerge.

The Role of Verbalization in Face Recognition

Verbal interference has been found in face recognition. Schooler and Engstler-Schooler (1990) showed participants a film of a bank robbery for 30 seconds. Subsequently, participants in the control group were given a five-minute irrelevant task (a reading comprehension task), and participants in the description group were asked to describe the face of the perpetrator for five minutes. They found a verbal description to reduce participants' accuracy in identifying the perpetrator from a line-up of faces. This was the first study that showed the verbal interference effect after verbal description of a single face, and termed the effect 'verbal overshadowing'. This was a single stimulus presentation paradigm, where participants viewed and described one target face and took part in a single line-up test, and subsequent studies have replicated this verbal interference effect on visual memory (e.g., Dodson et al., 1997; Fallshore & Schooler, 1995; Finger, 2002; Hunt & Carroll, 2008; Kitagami, Sato & Yoshikawa, 2002; MacLin et al., 2002; MacLin, 2002; Meissner, 2002). Meissner and Brigham (2001) showed by meta-analyses across 29 effect size with a total sample of 2,018 that the negative effect of verbalization was small but still reliable (Fisher's $Z_r = -0.12$). Additionally, several studies showed that verbal interference does not overwrite the original visual memory, and that the original visual memory can be retrieved under suitable conditions (Finger, 2002; Schooler & Engstler-Schooler, 1990), such as solving a maze or listening to music following verbalization, which then discourages the use of verbalization, prior to retrieval (Finger, 2002).

However, some studies used the same single stimulus presentation paradigm and found different results, most likely, because of changing some parameters of the paradigm. For example, Meissner, Brigham, and Kelley (2001) used the standard single stimulus presentation paradigm, where they asked participants to view a photograph of a single target face and then to describe that face and recognize it from a line-up, but influenced the verbal description criteria by changing the instructions to participants. They (1) instructed participants to give all the details of the face in their description even if they were not sure about them (forced description condition), (2) instructed participants to be conservative in their description and not to give details other than the ones that they were sure about (warned description condition), (3) used the standard instruction in the single stimulus presentation paradigm, where no response criterion was given to participants (standard description condition), or (4) did not ask participants to describe the face, but instead, asked them to list the states in the United States as a filler activity (control condition). They expected that instructions given to participants would affect the initial retrieval of the face during description, and this would then influence subsequent retrieval during face identification. This prediction was based on previous research (e.g., Kay & Skemp, 1956; Roediger, Wheeler & Rajaram, 1993) that attempted to lower participants' criterion for responding on a recall task. It was found that lowering participants' criterion for responding on one recall test can make them mistakenly recall items, and consequently, interfere with the accuracy of subsequent retrieval tasks. Additionally, they expected that accuracy of verbal descriptions would be positively correlated with performance in the subsequent face recognition task. Indeed, the results showed that verbal description in the forced description condition showed a larger number of errors compared to descriptions in the standard and the warned description conditions. Additionally, the type of instructions affected recognition performance, with the forced condition showing a lower level of performance compared to the standard condition, which in turn showed a lower level of performance compared to the warned condition. The standard condition did not differ from the control condition and therefore did not show the standard verbal interference effect. The absence of the verbal interference effect in the standard description condition was not consistent with previous single stimulus presentation paradigms (e.g., Schooler & Engstler-Schooler, 1990). However, there are other studies that have used the standard description instruction and a similar paradigm but failed to show the verbal interference effect (e.g., Lyle & Johnson, 2004; Memon & Bartlett, 2002). Critically, across description conditions, the performance in the recognition task negatively correlated with the number of errors in the verbal descriptions. Participants who made more errors in their descriptions were more likely to misidentify the face in the recognition test. The findings from this study indicate that the level of accuracy of the content of verbal description may be correlated with recognition performance. (See also MacLin et al., 2002; Meissner, 2002). However, it should be mentioned that not all studies have found this negative correlation between the number of errors in the verbal description and performance in the face recognition test (e.g., Brown & Lloyd-Jones, 2002; 2003; Kitagami et al., 2002). Nevertheless, the findings from this study provide evidence that description instructions can influence whether or not verbal interference is observed. (See also Finger & Pezdek, 1999; MacLin et al., 2002.) This has been also confirmed by the Meta-analyses by Meissner and Brigham (2001), where it was found that studies instructing participants to provide elaborate compared to standard face descriptions were more likely to show verbal interference effects.

The instructions given before verbal description are considered as an important parameter even within totally different paradigms. Brown and Lloyd-Jones (2002) compared the effect of two types of instructions in a multiple face presentation paradigm, where people were shown a series of faces and were then asked to describe or not for a period of five minutes the final face of the series. After the verbal description or the filler activity (counting backwards in threes) in the no description condition, participants performed old/new judgements for a sequence of faces, half of the faces were the same faces from the study phase (i.e., the target faces), not including the described face, and the other half were new faces (i.e., distractors). The target faces at test were presented from a different viewpoint in order to ensure that participants were performing a face recognition task rather than a picture recognition task (e.g. Sporer, 1991). The description and no description conditions were manipulated within subjects. Therefore, each participant had two blocks, where the participants performed the task with verbal description in one block and without verbal description in the other block. The instructions given to participants regarding the verbal description were manipulated between groups. Participants were either encouraged to describe in detail each part of the face, by giving them a list of all parts of the face to be described (i.e., the forehead, eyes, nose, mouth, chin, and ears) or encouraged to give a detailed description without giving them the list, so they were not required to describe each part of the face. Participants who were required to describe each part of the face showed lower recognition accuracy in the description condition compared to the no description condition, showing the verbal interference effect. In contrast, participants who were given instructions to describe the face in general, without being required to describe each part, did not show lower performance in the description condition compared to the no description condition. Additionally, analysing the verbal descriptions showed that participants, who were required to describe each part of the face, gave more featural descriptions compared to the group that gave a general verbal description. Featural description refers to specific features and details that are detached from the whole picture. Participants who gave a general verbal description of the face, in turn, gave more holistic descriptions compared to the former group. Holistic descriptions refer to holistic and general features of the stimuli, such as spatial layout and spatial relationship between features. However, analysing accuracy of verbal descriptions by analysing the number of errors given in each condition did not show significant difference between the two conditions. It should be mentioned that it might not be expected to find a relationship between recognition accuracy and description accuracy using this methodology as the described face did not appear in the recognition test, instead verbal interference occurred for previously seen, but non-described faces. These findings support the idea that the demands of the description task influence the content of the verbal description and at the same time influence performance in face recognition. Specifically, instructions to give featural descriptions resulted in participants giving more featural descriptors and this created verbal interference in the subsequent recognition test.

Furthermore, the order of the description and no description blocks might moderate participants' strategies whilst learning the faces. The findings from this multiple stimulus presentation paradigm showed that verbal interference was only found when the description block followed the no description block, but was not found when the no description block followed the description block. This was likely because participants after describing the last face in the first series continued to describe the faces in the second block. This kind of covert description is likely to be the reason why no difference was found between the description and the no description conditions when the description block preceded the no description block. (See also Brown & Lloyd-Jones, 2003).

Indeed, task demands before the learning phase may shift participants' strategies during encoding. For example, Brown and Lloyd-Jones (2005) inserted a short post verbal description during the learning of each face in the study phase, and participants were informed about this description task prior to encoding. Here, participants were asked to provide a subsequent brief description after each face (during a period of 15 seconds). All participants then performed an old/new recognition task immediately after the learning phase. The results showed that providing a verbal description for each face benefited face recognition compared to not describing the faces in a control group. (See also Brown & Lloyd-Jones, 2006;

Nakabayashi et al., 2011). These results contrasted with those found in the previously described multiple face presentation paradigms (e.g., Brown & Lloyd-Jones, 2002; 2003). When verbalisation occurred in-between each face presentation, there is evidence that even though the description is made post-encoding, participants changed their strategies during the encoding of the faces. There is evidence from an eye-tracking study for such a change in encoding strategies (Nakabayashi, Lloyd-Jones, Butcher & Liu, 2012). Nakabayashi and colleagues used a multiple face presentation paradigm similar to the paradigm by Brown and Lloyd-Jones (2005), and used eye-tracking to assess eye movement during the learning phase. Eye movement and eye fixations differed significantly between the verbal description and the no description conditions. However, there are other differences between this multiple stimulus presentation paradigm by Brown and Lloyd-Jones (2005) that showed verbal facilitation and other multiple stimulus presentation paradigms that have shown verbal interference (e.g., Brown & Lloyd-Jones, 2002;2003), which may contribute to the different results. These differences include the time given for verbal description and the number of faces in the series described. Brown and Lloyd-Jones (2005) gave participants 15 seconds to describe each face in the series. On the other hand, Brown and Lloyd-Jones (2002; 2003) gave participants five minutes to describe the last face in the series. In summary, finding the verbal facilitation effect in the multiple face presentation paradigm (e.g., Brown & Lloyd-Jones, 2005; 2006; Nakabayashi et al., 2011) in the opposite direction to the verbal interference effects (e.g., Brown & Lloyd-Jones, 2002; 2003), confirms the role of task demands in creating the conditions that give rise to either verbal interference or verbal facilitation effects.

Moreover, another task demand that has shown that verbalisation can benefit rather than interfere with face recognition is articulatory suppression (AS), which involves repeating irrelevant sounds whilst performing the main task. AS during encoding has been shown to prevent verbal recoding and to prevent verbal rehearsal of to be learned stimuli (Baddeley & Hitch, 1974; Morey & Cowan, 2004). This has been shown to impair face recognition performance and is evidence of the involvement of covert verbalization during the learning of faces (Wickham & Swift, 2006; Nakabayashi & Burton, 2008). For example, Wickham and Swift (2006) showed participants 12 faces, presented for five seconds each. Each face was followed by a one-minute overt verbal description or filler task (a crossword puzzle) and then a line-up of 10 faces, including the target face. The participants were asked to identify the target face. During the presentation of each face, participants were either involved in AS, where they repeated the word ‘the’ three times per second, or a control tapping task, where participants tapped the table three to four times per second. The tapping task is known to depend on spatial working memory and not to have any load on verbal or visual memory, and it was used to control for the effect of adding a concurrent task at encoding (Emerson & Miyake, 2004). The description vs. no description conditions were crossed with the AS vs. the tapping task, given in a total of four conditions. The findings showed that AS in the no description condition impaired performance in the recognition task compared to the control tapping task in the no description condition. This indicates that concurrent covert spontaneous verbalization is beneficial for face recognition. In contrast, when AS was absent during encoding, the overt verbal description was found to impair performance compared to the no description condition. This showed that the presence of an overt verbal description had an impairing effect on face recognition performance. (See also Nakabayashi & Burton, 2008). The importance of this study was that in contrast to the interfering effects of including an overt post-encoding description, it showed how AS during encoding illustrated a facilitative role of the verbal code in face recognition. It showed that AS might impair performance by suppressing covert verbalization during the learning of faces.

Finally, some task demands are important in moderating the strength of the relationship between verbalization and face recognition. Meissner, Sporer and Susa (2008) showed by meta-analyses across 33 studies with a total sample of 4278 participants a small but still significant relationship between description measures of accuracy, number of errors in descriptors and recognition accuracy. There was an effect of similarity between verbal description and the face described on recognition accuracy. More importantly, they show that task demands such as face recognition tasks rather than line-up identifications, number of targets in the paradigm and the length of delay between learning, description and recognition phases moderate the strength of the relationship between description and recognition accuracy. They suggest that when task demands allow participants to create a distinctive verbal description for each face, this prevents memory for each face from interference with memories of other faces. Having access to a distinct representation for each face strengthens the relationship between verbal description and face recognition. In contrast, Meissner et al. suggest that other task demands such as face encoding time and the duration given for verbal description do not moderate the relationship between verbal description and recognition accuracy.

To summarize, the findings from face recognition studies indicate that description instructions affect the content of verbalization and thereby moderate the effect of verbal interference. For instance, instructions that encourage featural description of faces succeed in influencing participants to generate more featural descriptors, and that featural description is more robust in producing verbal interference than global description (Brown & Lloyd-Jones, 2002). Additionally, requiring participants to give a large amount of information about the face and encouraging them to use guessing strategies results in forcing participants to produce more errors in their description; the more errors there were in verbal description the lower the performance in the face recognition task (MacLin et al., 2002; Meissner et al., 2001). Furthermore, instructions given to participants might change the strategy that participants adopt to encode the faces (Brown & Lloyd-Jones, 2005; 2006; Nakabayashi et al., 2011). Moreover, AS during the learning of faces showed interference in face recognition, and this implies a positive role for covert spontaneous verbalization in face recognition (Wickham & Swift, 2006; Nakabayashi & Burton, 2008). In fact, research in face recognition so far has given preliminary evidence that there are certain parameters that mediate verbal interference and verbal facilitation effects across several paradigms in face recognition. This suggests that research should focus more on identifying the parameters that mediate the effects of verbalisation on memory.

The Role of Verbalization in Picture Recognition

There are neuropsychological studies (e.g., Allison, Puce, Spencer & McCarthy, 1999; Halgren, Raij, Marinkovic, Jousmäki & Hari, 2000; Kanwisher, McDermott & Chun, 1997; Puce, Allison, Asgari, Gore & McCarthy, 1996), which suggest that recognition of faces activates the face fusiform area in the human brain that selectively responds to faces compared to other control objects. However, some studies (e.g., Diamond & Carey, 1986; Gauthier & Tarr, 2002) suggest that this functional neural area might respond to any visual stimulus that requires high level of perceptual expertise. Moreover, people are more likely to process faces differently from other visual stimuli because of social demands. People are required to distinguish between highly similar faces in their daily life interactions in order to react to them. In contrast, recognizing that a certain object is from a broad category is thought to be enough to be able to deal with the object, without the need to discriminate the object from other similar objects (Rosch, 1975). These differences in the nature of the stimuli between faces and pictures make it reasonable to discriminate between face recognition and picture recognition studies in the context of visual memory and verbal interference.

In addition, most of the studies in face recognition have changed the picture of the target face from the learning phase to the test, for instance, by changing the viewpoint of the face (e.g., Brown & Lloyd, 2002). Varying the image of the face between the experiment phases assured that the tasks were face recognition tasks rather than picture recognition tasks. However, such methods of changing the images might interfere with other aspects of visual memory such as memory of luminance or colours. On the other hand, picture recognition studies (e.g., Ellis, 1968) used the same stimuli in both the learning and the test phase. This methodological difference between face recognition studies and picture recognition studies might have a clear impact on the verbal interference effect in each task. Therefore, the discrimination between the two domains may be helpful in understanding the verbal interference effect in visual memory. Additionally, most of the studies in picture recognition used discrete labels whereas most of the studies in face recognition used detailed verbal descriptions. However, there are a few studies that have compared picture recognition with face recognition using detailed verbal descriptions with both types of stimuli (e.g., Brown & Lloyd-Jones, 2003; Nakabayashi et al., 2011).

Nakabayashi et al. (2011) compared the role of verbalization in the recognition of pictures of faces and in the recognition of pictures of objects, such as buildings and sculptures. Nakabayashi et al (2011:Experiments 1 & 2) used a multiple stimulus presentation paradigm, where participants viewed a series of 15 faces or 15 objects, for seven seconds each, and were then asked to perform an old/new judgement on a sequence of pictures, half of them were old (i.e., the same pictures as presented at study) and half were new. While participants were viewing the pictures during the study phase, they were either asked to perform the AS task, to perform the conventional tapping task, or to overtly describe the pictures while viewing them. Each task was undertaken for the same amount of time, for seven seconds per face. The results showed differential effects of AS and overt verbal description during the encoding of faces and objects. When pictures of faces were used, AS showed the lowest recognition performance compared to the tapping and the overt description conditions, which did not differ from each other. This indicates that both overt verbalization and covert verbalization are beneficial during memorization of a series of faces, but AS suppressed the use of covert verbalization: therefore, AS impaired performance in the recognition test. When pictures of objects were used, there was no significant difference between the AS condition and the tapping condition. Yet performance in the overt verbal description was improved compared to the other two conditions. This indicates that pictures of objects do not involve the use of covert verbalization during encoding, but performance was enhanced when overt verbal description was used. These results imply differential effects of covert concurrent verbalization and overt concurrent descriptions on faces and objects. Faces are highly similar stimuli and participants may be spontaneously using verbalization to distinguish between faces. This may account for there being no positive effect of additional overt verbalization. In the case of learning a sequence of pictures of objects, participants may not need to search for distinct features for each object. However, when participants are asked to use overt verbal description during the learning of each object, they may use the verbal description to emphasize distinctive features of each object. Therefore, performance in the recognition of pictures of objects was improved (Nakabayashi et al., 2011).

However, verbalization can be found to produce a similar effect on recognition performance of both pictures of faces and objects depending on the task demands (see Brown & Lloyd-Jones, 2003). Nakabayashi et al (2011: Experiments 3 & 4) used the multiple stimulus presentation paradigm, where participants were asked to learn a series of faces or objects. After that they were either asked to verbally describe any face they remembered from the series for five minutes or were asked to perform a filler activity (writing lists of school subjects, countries, or hobbies), and then perform an old/new recognition test. The results showed that post-encoding verbal description had a similar impairing effect on the recognition of both the previously non-described pictures of faces and objects. It was suggested that presenting faces and objects in a sequence may in both cases strengthen dependence on visual strategies that allow participants to find distinguishing visual aspects for each item in the sequence. Finding distinct visual aspects for each item may help participants in the recognition test, but post-encoding description may disrupt the use of such information during recognition. These findings indicate that recognition of pictures of faces and pictures of objects might be differently or equally affected by verbalization, depending on the task demands.

In addition, there are alternative methods to manipulate verbalization at encoding other than the use of AS and overt verbal descriptions, such as having experimenter-generated labels presented alongside the stimuli or asking participants to generate labels for the stimuli. Research in the picture recognition domain has shown that participants adopt different strategies to associate verbal labels with pictures depending on whether they viewed the verbal labels before or after (i.e., post-encoding) the pictures. For example, Verhaeghen, Palfai and Johnson (2006) examined how memory of abstract pictures is affected by presenting verbal labels during their learning. The design of their experiments was to learn a sequence of pictures (Chinese characters), followed by a recognition test, where participants in each trial were presented with the target paired with one foil and they were required to identify the picture they had previously learned. Experiment 1 in their study had three conditions: (1) only pictures were presented at encoding, and only one pair of pictures was presented in each trial at retrieval; (2) pictures were presented with verbal labels (unrelated concrete words) at encoding, and the verbal labels were presented again as cues with each pair of pictures; and (3) pictures were presented with verbal labels at encoding, but the verbal labels were not presented again at retrieval. The results showed that performance in the second condition, where the pictures were presented with the labels at encoding and the recognition test was cued with the labels at retrieval, was higher than the other two conditions. This experiment indicates that presenting pictures with verbal labels at encoding might create a verbal-visual association, which may improve performance in picture recognition. This association requires the presence of the verbal label at the recognition test in order to facilitate retrieval of the visual picture (See also Hockley & Bancroft, 2011). Following this, they ran an experiment with a similar design, but manipulated the order of the label and picture presentation during encoding. Each picture was either presented before its verbal label (condition 1), simultaneously with its verbal label (condition 2), or after its verbal label (condition 3). The verbal label was always presented at retrieval with the pair of pictures. The finding from this experiment showed that presenting the picture first and then the label resulted in lower performance compared to performance in the other two conditions. The findings from these two experiments argue that the relationships between the verbal labels and the pictures are created by searching for features in the pictures that can be extracted and associated with the verbal labels. Presenting the labels before the pictures during the learning phase, allows the creation of the verbal-visual association, and improves recognition performance by using the verbal labels as cues at retrieval. On the other hand, presenting the labels after the pictures during the learning phase does not help in creating the verbal-visual association and does not make the verbal labels helpful in the recognition test. This is clear evidence of how task demands at encoding can influence the association between the pictures and the verbal labels and thereby moderate the role of the verbal code in picture recognition.

The content of the verbal labels given to pictures can also be important in determining the role of the verbal code in picture recognition. Ellis (1968) asked participants to memorize a sequence of pictures (simple line drawings) presented in a sequential order at a rate of four seconds per picture. Each shape was followed by a written name that either matched or did not match the shape. They then immediately tested participants' recognition of the pictures where each trial presented a line-up consisting of five pictures, and where the target picture might or might not be present in the line-up. The results showed that performance when the labels consisted of information that matched the shapes was higher than performance when the labels were irrelevant to the shapes. This indicates that picture recognition benefits from presenting verbal labels at encoding which match the semantic information contained in the shapes (See also Daniel & Toglia, 1976; Nelson & Kosslyn, 1976).

Turning to another important parameter, remembering the serial order of pictures might influence the role of the verbal code in picture recognition. It is implied that when task demands require recalling the serial order of the pictures, the verbal code has a positive role. This was shown by a study by Poirier, Saint-Aubin and Musselwhite (2007) within the domain of immediate short-term memory. Memory of a series of easy-to-name line drawings of objects (e.g., button and ball) was studied. The pictures were either highly visually similar (e.g., they shared the same round outlines or had elongated shapes) or were visually dissimilar. Each trial included a series of six pictures, presented for one second each. Additionally, when participants were viewing the pictures they were either asked to perform AS or were not asked to perform AS. Immediately after each presentation, participants were shown a row of the six pictures they had learned and were asked to write their sequential order. A strict serial recall criterion was used, where a score was given for the shape when it was given the number that corresponded to the shape position during the learning phase. The results showed lower memory performance for the AS condition compared to the no AS condition indicating a positive effect of covert spontaneous verbalization. Additionally, under the AS condition only, memory for the order of the highly visually similar pictures was lower than memory for the order of the visually dissimilar pictures. In the no AS condition, memory for order of the visually similar and dissimilar pictures was not found to be different, though this may be due to ceiling effects in this condition. Nevertheless, the effect of AS was selective, suggesting that the decrease in performance by AS was not due to a general disruption of mental processing by this concurrent task. AS suppressed the use of the verbal code which was important for recalling the order of highly visually similar pictures in immediate short term memory and thereby impaired performance in the serial position re-ordering task. This finding leaves the question open for whether the use of the verbal code in learning a sequence of pictures is involved in learning the serial order of the pictures in long-term memory. This question is important in the field of the role of verbalization within visual memory. It may assist the understanding of how the verbal code might show different effects depending upon whether or not participants are asked to learn the order of pictures.

In summary, both face recognition and picture recognition studies (e.g., Brown & Lloyd-Jones, 2003; Nakabayashi et al., 2011) suggest that the use of verbalisation may exert similar effects depending on task demands. Research in picture recognition has provided some information concerning the parameters that mediate both verbal interference and verbal facilitation effects. For example, the time when labelling (Verhaeghen et al., 2006) or overt description (Nakabayashi et al., 2011) takes place, the content of the labels (Ellis, 1968) and the nature of the stimuli (e.g., faces or objects (Nakabayashi et al., 2011), visually similar or dissimilar objects (Poirier et al., 2007) and easy to name (Poirier et al., 2007) or not easy to name shapes (Verhaeghen et al., 2006)) all may mediate verbal interference and verbal facilitation effects. Additionally, there is the speculation that demanding that participants recall the sequence order of learned pictures might be an important parameter that mediates the positive effect of verbalization effect within picture recognition (Poirier et al., 2007; Saint-Aubin & Poirier, 1999).

The Role of Verbalization in Visual Imagery

Visual imagery as a measure of visual memory is based on the idea that we process mental images in the same way that we process real physical images (Finke, Pinker & Farah, 1989; Kosslyn, 1994). The visual imagery domain is useful for exploring the relationship between verbalisation and visual memory, as verbal interference and verbal facilitation effects have been observed within the same paradigm (e.g., Brandimonte & Collina, 2008; Brandimonte et al., 1997). For example, Brandimonte and Collina (2008) showed that self-generating labels to a series of visual shapes following their encoding impaired subsequent memory for those forms, but that presenting those labels at retrieval removed verbal interference and enhanced visual memory. Furthermore, similar observations have been shown within both face recognition and visual imagery paradigms. For example, in both paradigms, the original visual memory is not eradicated. The existence of an intact original visual representation in spite of verbalization of visual items is a common finding among both visual imagery (Brandimonte et al., 1997; Pelizzon et al., 2002; Brandimonte & Collina, 2008) and face recognition paradigms (Finger, 2002; Schooler & Engstler-Schooler, 1990). Moreover, similar materials have been used within both visual imagery and picture recognition paradigms. For example, in both paradigms the materials used were mostly pictures with discrete labels (e.g., Brandimonte et al., 1992a; Ellis, 1968).

Brandimonte et al. (1992a) developed the mental rotation task to study verbal interference on visual imagery. In their paradigm, they used two sets of shapes containing embedded letters. When rotated, each shape revealed two English letters joined together. The two sets of shapes were: easy-to-name shapes, assumed to be spontaneously named by people, and hard-to-name shapes, which were assumed not to be spontaneously named by people. See Figure 1 for examples. Participants memorized the set of easy-to-name or hard-to-name shapes before they learned about the embedded letters. During the learning phase, the shapes were presented to participants three times at a rate of five seconds for each shape. Thus, the participant viewed each shape for 15 seconds. During encoding, the shapes were laid down in a row on the table and participants viewed them one-by-one, in the same order across all three presentations. Thus, as well as the visual to-be-remembered information, participants were also provided with both spatial (i.e., the position of the shape in the row) and temporal (i.e., the point at which the shape appeared in the sequence) information (i.e., a spatial-temporal method of presentation). After the learning phase, participants were asked to check that they could recall the visual shapes to mind in the order they were learned with 100 % accuracy. After that, they were informed that the shapes consisted of embedded letters, and practiced the mental rotation and discovery task on a practice shape. They then generated the shapes from memory and performed the rotation task in order to identify the hidden letters. The cards containing the shapes were left in the same positions face down on the table, enabling participants to view the spatial positions of the shapes (i.e., providing spatial cues to retrieval), and participants also recalled the shapes in the same temporal order in which they were learned (i.e., providing cues to temporal order at retrieval). The results showed that participants who had learned easy-to-name shapes identified fewer hidden letters than those who had learned the hard-to-name shapes. In the same experiment, Brandimonte and colleagues manipulated AS during the learning phase. The results showed that AS, compared to no AS, at encoding had a positive effect on later rotation of easy-to-name images, improving the discovery of the hidden letters, and thereby preventing the verbal interference effect. Indeed, performance associated with easy-to-name images with AS at encoding was at the same level as hard-to-name images. No effect of AS at encoding was found on performance associated with hard-to-name shapes. These observations support the idea that when covert spontaneous labelling is present (i.e., in the case of easy-to-name shapes) interference occurs. Under conditions where covert spontaneous labelling is absent (i.e., with AS or when encoding hard-to-name shapes) verbal interference is not apparent and performance in the imagery task is higher.

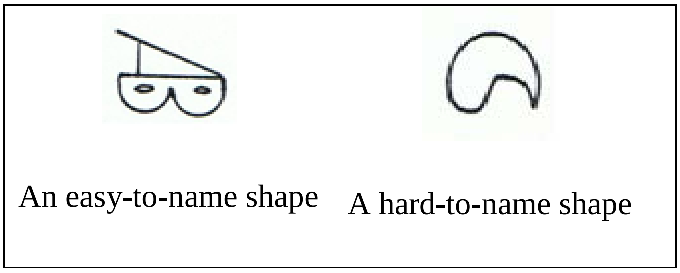


Figure 1. Examples of easy-to-name and hard-to-name shapes.

Reprinted from "Verbal Recoding of visual stimuli impairs mental image transformations," by M. A. Brandimonte, G. J. Hitch, and D. V. Bishop, 1992. *Memory & Cognition*, *20*, p. 450. Copyright 1992 by Springer Science & Business Media. Reprinted with permission. See Appendix A for the licence.

Moreover, spontaneous naming is not tied to one specific visual imagery paradigm. Brandimonte et al. (1992b) developed the mental subtraction paradigm, which had a similar rationale to the mental rotation paradigm. They used shapes that could reveal new patterns after subtracting parts from the original shapes (e.g., a shape of a sweet reveals a shape of a fish after removing one triangle). Two sets of shapes were used: easy-to-name shapes and hard-to-name shapes. Again the same spatial-temporal presentation method (whereby spatial and temporal order cues were available at encoding and retrieval) was used as in the rotation paradigm. At retrieval, for each shape, participants were shown a picture of the part that they had to remove from the shape, and were asked to give their resulting answer verbally.

Again, AS was manipulated at encoding. The results of this subtraction paradigm replicated findings from the mental rotation paradigm. These findings indicate that spontaneous naming is not restricted to one specific visual imagery paradigm (see also Pelizzon et al., 1999).

In addition, task demands set-up at retrieval might remove verbal interference and facilitate performance. A study by Pelizzon et al. (1999) showed a differential effect of spontaneous naming at encoding in a visual recognition task and an image manipulation task. They used the mental subtraction paradigm by Brandimonte et al. (1992b) and manipulated AS during the encoding of easy-to-name shapes. Additionally, they developed a picture recognition paradigm that used the same presentation method during encoding as the mental subtraction paradigm, but the retrieval task was different. Participants in the recognition task were verbally given the answer to the subtraction task, after viewing the picture of the part that should be removed from the shape, and were then asked to choose the resulting shape from four alternative choices. As expected, AS benefitted performance in the image manipulation task, relative to the no AS condition. This again indicates the negative effect of covert spontaneous naming on visual memory. In contrast, AS impaired performance in the recognition task compared to the no AS condition, implying that covert spontaneous naming might be beneficial for recognition. In fact, giving participants the verbal answer for the subtraction task prior to identification of the picture from the line-up at retrieval may have encouraged dependence on verbal processing at retrieval. Hence, the verbal codes generated via spontaneous naming during encoding may have then been usefully applied at retrieval. These findings indicate that spontaneous naming at encoding might hurt or facilitate visual memory depending on the task demands set-up at retrieval.

Other research also indicates that the role of covert spontaneous naming might be beneficial in the domain of visual imagery depending on the task demands at retrieval. Hitch et al. (1995) used pairs of cards; each pair together revealed a picture of an object. The members of each pair were either congruent in their colours (i.e., the two members of the pair had the same colour) or incongruent in their colours (i.e., each member of the pair had a different colour). Participants were presented with the first member of each pair using the common spatial-temporal presentation method used in previous experiments (i.e., the shapes were laid down in a row, and participants viewed them one-by-one, in the same order across all presentations). The first member of each pair was an easy-to-name shape, and participants were either engaged in AS or did not engage in AS during the presentation of the shapes. At retrieval, participants were presented with the second card of each pair and were asked to image the two members of each pair and combine them in order to discover the resulting object. The results did not show any effect for AS vs. no AS during encoding of the pairs with congruent colours. In contrast, the results revealed lower performance for the incongruent colour pairs with AS (i.e., fewer objects were discovered) compared to no AS. It was proposed that AS prevented verbal encoding and therefore retained the surface features of the shapes. When the surface features mismatched, as in the case of the presence of two incongruent colours, this interfered with the ability to combine the pair of shapes to discover a new object. In contrast, covert spontaneous naming may have improved performance by shifting the representations of the shapes to abstract representations that lost the surface features of the shapes, in this case their colour features. Thus, spontaneous naming improved performance when combining the two members of a pair with incongruent colours. These results reflect how verbalization in visual memory might hurt or improve performance depending on the task demands. Here successful performance in the incongruent pairs required a shift to an abstract representation, and thus verbalization facilitated imagery performance.

Research in visual imagery is not restricted to the manipulation of covert spontaneous naming via AS during encoding, but has also examined explicit labelling via provision of experimenter-generated labels during encoding. Brandimonte et al. (1992a) used the mental rotation task (with the spatial-temporal presentation method) in conjunction with experimenter-generated labels, written below the shapes and presented at the same time during encoding. The labels were the most common names given by 16 participants, who performed a preliminary naming agreement test. The results showed that providing verbal labels had a negative effect on later rotation of hard-to-name shapes, and performance on hard-to-name shapes dropped to the level of performance on easy-to-name shapes. Providing verbal labels had no further effect on easy-to-name shapes. These observations illustrate that experimenter-generated labels may have a similar impairing effect to spontaneous verbal encoding. It is worth mentioning that most of the studies in visual imagery (e.g., Brandimonte et al., 1992a; 1992b) have manipulated explicit labelling during encoding and showed the verbal interference effect for hard-to-name, but not easy-to-name shapes, but one visual imagery study has manipulated the explicit labelling of hard-to-name shapes at post encoding and, also, found the verbal interference effect (Brandimonte & Collina, 2008).

In addition, research in visual imagery has manipulated cues at retrieval and provides clear evidence that suitable cues can remove the verbal interference effect and facilitate performance. Brandimonte, Schooler and Gabbino (1997) used the mental rotation paradigm (with the temporal-spatial presentation method), and showed that when easy-to-name shapes are presented on coloured cards during learning, presenting the colours of the cards as cues at retrieval improved performance in the image manipulation task compared to the no cue condition. In contrast, retrieval of the shapes without seeing the colour cues showed verbal interference. Colour cues were proposed to attenuate the negative effect of verbal interference (i.e., that arose via covert spontaneous naming of the easy-to-name shapes) because they were related to the detailed visual representations of the shapes. Presenting the colour cues was assumed to emphasize the use of the visual code, and to de-emphasize the use of the verbal code. According to these results, presenting a colour cue at retrieval improved performance because it facilitated access to the original visual representation of the shape. This beneficial effect of colour cues was found in another condition where the shapes were hard-to-name shapes presented with verbal labels during learning. There was a benefit for verbally labelled hard-to-name shapes with colour cues compared to the verbally labelled hard-to-name shapes with no cue condition. It was known that presenting verbal labels on hard-to-name shapes creates verbal interference (Brandimonte et al., 1992a). Yet presenting the colours of the background as cues at retrieval removed the verbal interference effect. These findings illustrate that cueing at retrieval influences the role of verbalization in visual memory. Additionally, these results provide evidence that both covert spontaneous naming and explicit labelling during encoding do not overwrite the accurate visual mental representation. The original visual representation is still intact and under suitable conditions can be accessed to complete the imagery task (see also Brandimonte & Collina, 2008). In fact, research on face recognition has similarly shown the original visual representation to still be accessible under suitable conditions. Such common findings between visual imagery paradigms and face recognition paradigms suggests that the parameters that moderate the role of verbalization can in instances be similar across different domains in visual memory.

Visual cues that can remove the negative effect of verbal interference are not restricted to colour cues. Background shapes can also remove the negative effect of verbal interference. This was shown by Pelizzon et al. (2002), using the mental rotation paradigm (with the temporal-spatial presentation method). When easy-to-name shapes were presented on cards of hard-to-name shapes, presenting the card shapes as cues at retrieval improved performance compared to no cues at retrieval (Pelizzon et al., 2002).

Pelizzon et al. (2002) also examined the extent to which different presentation methods may mediate the beneficial effects of visual cues in retrieving easy-to-name shapes. For some participants they used a spatial presentation method whereby during the learning phase the shapes were presented in a row in front of participants, and participants viewed them one-by-one, in a different order during each of the three presentations. In this method spatial cues were emphasised, but participants were not able to utilise cues concerning temporal order to assist them at retrieval. For other participants they used a temporal presentation method whereby the shapes were presented in a single pile in a sequential order without being laid in a row. In this method temporal order cues were emphasised, but participants were not able to utilise cues concerning spatial position to assist them at retrieval. In addition, the standard spatial-temporal presentation condition was included. Participants were then asked to retrieve the shapes either by order or position cues according to the presentation method at encoding or by a conjoint use of visual cues and order/position cues. Pelizzon et al. showed differential effects of visual cues depending upon whether the spatial or temporal presentation methods were used.

The positive effect of visual cues was found when the shapes were presented spatially. This finding was similar to the finding of positive effects of visual cues in the spatial-temporal presentation method. In both spatial and spatial-temporal presentation methods, spatial cues were available to be used at both encoding and retrieval. Spatial cues might be necessary to allow the participant to link the shape with its background (the visual cue), and hence, benefited from the visual cue when presented at retrieval. In contrast, visual cues did not help performance in the temporal presentation method, and performance was equivalently high both with and without background shape cues. In this case, spatial cues were not available, and so visual cues did not have the same positive effect found in the spatial presentation method. Instead, the temporal presentation method emphasized information about the order of the shapes (i.e., the point at which the shape appeared in sequence). Thus, an emphasis on order information may be a task demand that gives rise to beneficial effects for the role of verbalization in visual imagery (Pelizzon et al., 2002). In fact, it seems that memory for order may mediate performance in visual imagery. However, Pelizzon et al. did not provide a direct comparison between the temporal presentation method and the spatial presentation method when visual cues were not provided at retrieval. Thus, the question of whether use of a temporal presentation method mediates the use of the verbal code in learning the visual stimuli for retrieval in a subsequent mental imagery task should be examined.

To summarize, research in visual imagery has identified several parameters that mediate the role of the verbal code in visual memory. Generally, the findings from visual imagery studies indicate that varying the task demands set up during encoding (e.g., AS during encoding, the use of easy- or hard-to-name forms) and retrieval (visual and verbal cues) influences the conditions that moderate the role of spontaneous covert naming and explicit labelling in visual memory (e.g., Brandimonte et al., 1992a; 1992b; Hitch et al., 1995; Brandimonte et al., 1997; Pelizzon et al., 2002; Brandimonte & Collina, 2008). Additionally, method of presentation may be an important parameter and needs to be further explored (Pelizzon et al., 2002).

Theories of Verbal Interference and Facilitation

Research in the three domains reviewed in visual memory has shown the importance of task demands in creating the circumstances that moderates the effects of verbalization on memory performance. Multiple accounts of the influence of verbalisation on memory have been put forward within each domain and broadly these accounts fall into three main categories: the processing shift account; the representation shift account; and the criterion shift account (for a review see Chin & Schooler, 2008; Lloyd-Jones, Brandimonte & Bauml, 2008; Schooler, 2002). These accounts have focused largely on the impairing effect of verbalization on visual memory. However, other accounts may be relevant, especially when focusing upon the beneficial effects of verbal encoding. These accounts may relate to representations, as they seem to refer to strengthening representations (Daniel & Toglia, 1976; Ellis, 1968; Santa, 1975) or using both verbal and visual information in conjunction (Bahrick & Bahrick, 1971; Paivio, Philipchalk & Rowe, 1975; Verhaeghen et al., 2006). Therefore, it seems that no one account can explain all findings. Several researchers have suggested that different mechanisms may be at play depending upon the different task demands adopted in different paradigms (e.g., Chin & Schooler, 2008). Generally, the accounts that are related to the role of verbal and visual processing and verbal and visual representations can account for many findings in the area, and are discussed below. In contrast, the criterion shift theory argues that verbalizing visual stimuli does not interfere with retrieval of the visual stimuli, but it makes participants less willing to identify any stimulus as having appeared earlier in a study phase. Based on this account, verbal interference is apt to occur after verbalization in an optional recognition test, where participants are given the option to reject all the alternatives in line-up recognition. Verbalization encourages participants to reject all the members in the line-up. In contrast, verbal interference is less likely to occur after verbalization in forced recognition tests, where participants are instructed to choose one of the presented members of the line-up (Clare & Lewandowsky, 2004). However, a shift in criterion cannot explain many results of verbal interference in the face recognition literature. Some studies using forced choice line-ups have found verbal overshadowing effects (e. g., Fallshore & Schooler, 1995; Schooler & Engstler-Schooler, 1990). Additionally, this theory is not relevant to the visual imagery domain, which involves cued recall and image manipulation because this theory can deal only with tasks that involve identifying the target as having seen before.

The Role of Verbal and Visual Processing

The most influential account for the role of verbal and visual processing in visual memory is the processing shift account. This largely refers to verbal interference and suggests that verbalization reduces dependence on visual processes and emphasizes verbal processes (Schooler & Engstler-Schooler, 1990). It assumes that a shift from visual to verbal processing disrupts memory of stimuli that cannot be captured by words (e.g., faces and colours) (Polanyi, 1966 as cited in Fallshore & Schooler, 1995). An alternative shift of processing might be a shift from global processing (i.e., the processing of holistic and general features of the stimuli, such as spatial layout and the spatial relationship between features) to featural processing (i.e., the processing of specific features and details that are detached from the whole picture) (Fiore & Schooler, 2002; Macrae & Lewis, 2002). This shift from global to featural processing can impair face recognition. This is because faces are typical examples of stimuli that are globally represented in memory (Yin, 1969), and face recognition, therefore, is better performed when participants process the face in a global manner (Brown & Lloyd-Jones, 2002: Fallshore & Schooler, 1995). Hence, verbalization of faces has been found to impair face recognition because it shifts the processing from global to featural processing (Chin & Schooler, 2008; Fallshore & Schooler, 1995; Schooler, 2002).

The processing shift theory can capture robust observations on verbal interference, such as the finding that a post-encoding description of one item in a series can impair recognition memory of other non-described visual stimuli in that series (Brown & Lloyd-Jones, 2002; 2003; Weston, Perfect, Schooler & Dennis, 2008). This indicates that verbalization can create a general processing shift. The general processing shift continues until the time of retrieval giving rise to an emphasis on processing that was less suited to the retrieval task and thereby recognition performance was impaired even for stimuli that were not described previously. Additionally, the processing shift theory is further supported by the finding that verbal interference, after post-encoding description, can be alleviated by involving participants in irrelevant non-verbal tasks prior to retrieval, such as listening to music (Finger, 2002). The non-verbal activities prior to retrieval reduced dependence on verbal processes and again emphasized the non-verbal processes, which were appropriate for retrieval of the visual stimuli (Finger, 2002). Thus the processing shift theory suggests that verbal interference can occur without assuming that a new representation of the stimulus is created by verbalization, and can account for many findings in the face recognition domain (e.g., Brown & Lloyd-Jones, 2002; 2003; Dodson et al., 1997; Fallshore & Schooler, 1995; Nakabayashi & Burton, 2008; Nakabayashi et al., 2011; Schooler & Engstler-Schooler, 1990) as well as the picture recognition domain (Brown & Lloyd-Jones, 2003; Nakabayashi et al., 2011). However, as this account suggests that verbal interference is due to a general shift of processing, it is not enough to explain the findings of a subset of studies that have shown a significant negative correlation to occur between the numbers of errors in verbal descriptions and face recognition memory performance (Meissner et al., 2001). Additionally, the processing shift theory cannot account for several findings in visual imagery, where imagery performance was impaired but verbal processing was involved at both encoding and at retrieval (e. g., Brandimonte et al., 1992a; 1992b; Pelizzon et al., 1999). The processing shift theory suggests that when the processing of stimuli at encoding and retrieval are the same, memory of the stimuli should not be impaired. On this basis, it has been suggested that an alternative account involving a shift between different types of stimulus representations might better explain findings from the visual imagery domain (cf., Brandimonte & Collina, 2008).

The Role of Verbal and Visual Representations

The most common account for the role of verbal and visual representations in visual imagery is the representation shift account. The representation shift account assumes that verbalization shifts the representation of the original visual memory, based on the content of the verbalization (Carmichael, 1932; Meissner et al., 2001). A new representation is thought to be developed that in some way relates to the verbal description (Mandler & Ritchey, 1977). In this case, poorer quality of verbalization should strengthen the effects of verbal interference (Meissner et al., 2001).

This representation shift account has been successfully applied to some verbal interference findings in the face recognition domain (Meissner et al., 2001) as well as the picture recognition domain (e.g., Lupyan, 2008). However, some studies in face recognition have failed to find a correlation between description quality and recognition accuracy (e.g., Brown & Lloyd-Jones, 2002; Kitagami et al., 2002), and these findings do not support the assumption that poorer quality of verbalization increases the verbal interference effect. Additionally, this account cannot explain why describing one stimulus impairs memory for other non-verbalized stimuli (e.g., Brown & Lloyd-Jones, 2002; 2003). Verbal interference, according to the representation shift account, occurs because the new representation interferes with access to the original visual representation. Non-verbalized stimuli do not have such disrupting representations.

In the imagery domain, it has been shown that the shift is likely to be more than one from a verbal representation to a visual representation. Brandimonte and Collina (2008) suggest that the shift may be one of emphasis, from a featural representation to a global representation. Given that visual imagery benefits more from featural representations, shifting the emphasis from featural representations of visual shapes to global representations impairs performance in the visual imagery task. In the picture recognition domain, Lupyan (2008) presents an account, with a similar emphasis on a shift between different types of representations, suggesting that explicit verbal labelling creates a shift of emphasis from the actual representation to a prototypical representation of the picture. Hence, the unique identity of the original representation is lost. The idea of the shift toward a prototypical representation of the picture suggests that the representation is changed in memory by a top-down modulation to a prototypical image. Hence, the shift of emphasis from the actual image to the prototypical image can be large or small depending on the level of match between the stimulus and the prototypical image. Pictures that are strongly linked with their labels strongly activate the prototypical image and should show a larger shift of emphasis onto the prototypical image. In contrast, pictures that possess weaker links with their labels are expected to show a smaller impairing effect of verbal labels. Thus, this particular account suggests that the size of the representational shift depends on the link between the stimulus and the verbal label.

There are other accounts however, that suggest a positive role of verbalization. These accounts also relate to the role of representations, but do not suggest a shift in emphasis between different types of representations.

These include accounts that imply the verbal code plays a role in strengthening the encoding of visual stimuli. Ellis (1968) and Daniel and Toglia (1976) suggest that explicit verbal labels might be used to strengthen the encoding of the shapes by emphasizing the processing of semantic information. The integrative account, also, indicates that verbal labels may strengthen the encoding of the shapes, but suggests that this is achieved by unifying the visual features of the shapes into a single visual unit (Santa, 1975). Similarly, overt verbal labels or description may strengthen the representation of the stimulus by improving the encoding of visual information (e.g., its amount or quality) (Winograd, 1981), by adding semantic information (Bower and Karlin (1974), or by improving encoding of both visual and semantic information (Klatzky, Martin & Kane, 1982). These accounts have emphasized the role of the verbal code in strengthening the encoding of the stimulus, and thereby leading to better memory performance at retrieval.

However, the verbal code may additionally be useful at the time of retrieval. Verbal information might be bound with the visual information during encoding, and therefore could be used to cue the visual representation as a whole at retrieval (Bahrick & Bahrick, 1971). Another possibility is that when attention to the temporal order of the stimuli is emphasized, the verbal code might be used to encode both the shapes and their temporal order at encoding, and then be used again to recall the shapes in their temporal order at retrieval (Paivio et al., 1975). This might be the case because the verbal code in terms of retaining temporal order decays slower than the visual code (Dainoff, 1970).

On the other hand, there may be contexts where relying on memory for verbal information at retrieval may lead to impaired memory for visual stimuli. For example, the pair association account, focuses on linking verbal and visual representations, and has been applied only to studies that have used explicit verbal labels (e.g., Hockley & Bancroft, 2011; Verhaeghen et al., 2006). This account implies that presenting explicit verbal labels alongside stimuli at encoding associates verbal and the visual representations together into pairs, and hence, the verbal label at retrieval can be used to cue the whole pair (Verhaeghen et al., 2006). It also suggests that presenting explicit labels alongside the stimuli during encoding impairs performance because words are more susceptible to forgetting compared to pictures (Ally & Budson, 2007; Nelson, Reed & Walling, 1976; Shepard, 1967) and that forgetting a member from a pair can then disrupt memory for that whole pair (Hockley & Bancroft, 2011; Sakai & Miyashita, 1991).

Although similar findings are found across face recognition, picture recognition and imagery tasks, there is preliminary evidence that they do not arise from the same underlying mechanisms. It seems that the face recognition studies favour, under different task demands, both theories related to the role of verbal and visual processing and theories that are related to verbal and visual representations. In contrast, the visual imagery studies show preference to the role of verbal information that is related to the visual representation. These studies have emphasized the shift of representation account and have shown that the effect of verbalization is not general but rather specific and visual memory of the shape can depend on the accuracy of the verbal label attached to the shape (e. g., Brandimonte & Collina, 2008). However, taking note of picture recognition studies, which have used explicit labelling, highlights other possible accounts that focus on verbal information, such as accounts that are related to strengthening representations (e.g., Daniel & Toglia, 1976; Ellis, 1968; Santa, 1975) or accounts that are related to using both verbal and visual information in conjunction (e.g., Bahrick & Bahrick, 1971; Paivio et al., 1975; Verhaeghen et al., 2006). Therefore, it seems that there is no single theory that can account for all the literature in verbal interference and facilitation with visual memory. Furthermore, effects of verbalisation can be fragile. For example, several studies have not replicated the verbal interference effect (e.g., Lyle & Johnson, 2004; Memon & Bartlett, 2002). Thus it seems that different parameters can mediate the presence or absence of verbal interference or facilitation within visual memory (e.g., demanding participants to recall the order of the stimuli) (Pelizzon et al., 2002; Poirier et al., 2007).

Questions of the Study

Research in the area of visual memory has shown the importance of identifying parameters that mediate the role of the verbal code. The programme of study in this thesis identified the method of presentation (e.g. spatial and temporal presentation) as its primary parameter (see Pelizzon et al., 2002), and first aimed to study how the method of presentation (temporal or spatial) interacts with the presence and absence of verbalisation (manipulated via the use, or not, of AS) at encoding (Experiments 1, 2 & 3), and at retrieval (Experiments 2 & 3). This manipulation is novel and showed that the emphasis on the use of the verbal code depends upon the method adopted when presenting the stimuli during both encoding and retrieval. The results from Experiments 1, 2 and 3 did show that when emphasizing order information by the use of temporal presentation memory performance on an imagery manipulation task benefited from the use of the verbal code. Hence, the following question in this thesis was related to the difference between explicit labelling and covert spontaneous naming when using a temporal presentation method (Experiments 4, 5 and 6). This provided evidence that the temporal presentation method interacts with task demands, such as the presence or absence of explicit labels, to influence the usefulness of the verbal code for the memory task. The use of explicit labelling also lent itself to examining the role of the content of the verbal code in determining memory performance. In addition, the effects of presenting verbal cues during retrieval were examined (Experiment 5). The experimental findings showed that the contents of the verbal code can influence memory performance within the context of a temporal presentation method. Finally, it was shown that the effects of the temporal presentation method were not restricted to the mental rotation paradigm, but could be replicated in a mental subtraction paradigm using novel stimuli (Experiments 7 & 8). All in all, the study was focused on the idea that certain parameters or task demands play critical roles in influencing the effects of the verbal code and that they should be carefully reviewed and examined. The parameters examined in this research included the method of presentation (spatial vs. temporal presentation method), AS at encoding, AS at retrieval, type of cues (appropriate verbal cues and non-word verbal cues), and the nature of the label (self-generated, experimenter-generated, and spontaneous naming).

Chapter 2: Spontaneous Naming at Encoding and Presentation Methods in the Mental Rotation Paradigm

Introduction

The key findings from studies in visual imagery so far have shown that naming whether manipulated implicitly (i.e., through the use of easy-to-name vs. hard-to-name shapes, e.g., Brandimonte et al., 1992a; Brandimonte et al., 1992b, or the use of AS vs. no AS, Brandimonte et al., 1992a; Brandimonte et al., 1992b; Brandimonte & Gerbino, 1993; Pelizzon et al., 1999) or explicitly (i.e., via labelling vs. no labelling, e.g., Brandimonte et al., 1992a) impairs performance on an imagery manipulation task. However, there is evidence that particular task demands may influence whether or not naming impairs performance or has no effect (Brandimonte et al., 1997; Pelizzon et al., 2002).

Task demands have previously been manipulated by emphasising different features integral to the stimulus, such as the background colour (Brandimonte et al., 1997) and background shape (Pelizzon et al., 2002). Previous research indicates that when spontaneous naming of easy-to-name shapes themselves is encouraged verbal interference is present on the later visual imagery task. In contrast, when task demands encourage other aspects of the stimulus to be named (i.e., background shape or colour) verbal interference does not occur on the later visual imagery task (Brandimonte et al., 1997; Pelizzon et al., 2002). For example, Pelizzon et al. (2002: Experiment 1) used the spatial-temporal presentation method and showed that presenting hard-to-name backgrounds compared to easy-to-name backgrounds around easy-to-name shapes during their encoding led to lower performance on the visual imagery task. It appears that the hard-to-name backgrounds at encoding encouraged the verbal encoding of the easy-to-name shapes themselves and thereby produced the verbal interference effect on the later visual imagery task. In contrast, the easy-to-name backgrounds encouraged participants to name the background shapes instead of the to-be-remembered easy-to-name shapes and therefore the easy-to-name shapes did not experience verbal interference. Thus it seems in this context that the content of the verbal code in terms of whether it refers to, and interferes, with aspects of the stimulus that are necessary for successful performance on the memory task, or whether it applies to non-necessary aspects of the stimulus, and so does result in interference (e.g., background colour), will determine how the presence of verbal encoding subsequently influences performance on the memory task. Additionally, they showed that presenting the hard-to-name background shapes as cues at retrieval removed verbal interference arising from the naming of the easy-to-name shapes and improved performance. This shows that the original visual trace is not lost and can be accessed via the use of relevant visual retrieval cues.

Pelizzon et al. (2002: Experiment 3) further examined how the way in which the stimuli are physically presented during encoding and retrieval can influence effects of verbal interference. If the presentation method at encoding and at retrieval mediates the effect of background shape cues at retrieval, then there should be differential effects on imagery performance depending on the method of presentation. They used the mental rotation paradigm with six to-be-remembered easy-to-name shapes. They presented the shapes on backgrounds of hard-to-name frames at encoding. There were three presentation methods at encoding: spatial, temporal, and spatial-temporal. In the spatial condition, the shapes were laid in a row on the table and turned over one-by-one. They were shown to participants three times, and were shown in a different order each time (so that temporal cues were absent). In the temporal condition, the shapes were not laid in a row but were hidden under the table (so that spatial cues were absent) and were shown one-by-one. The order in which the shapes were shown was the same for all three presentations. In the spatial-temporal condition, the shapes were presented in a row and were shown in the same order all three times. The method of presentation used at encoding was later used as a cue at retrieval. The spatial cues were shown by pointing to each of six dots on a strip of paper that represented the spatial position of the shapes during encoding (spatial position). The temporal cues were given by verbally asking participants to recall the shapes in the order used at encoding (temporal order position). The spatial-temporal cues were shown by pointing at the paper strip to the spatial position of the shapes this time in the same order used at encoding (spatial-temporal order position). The shapes of the background were also presented as visual cues prior to retrieval. The encoding position cues and the background shape cues were presented either separately or together. Additionally, there was a ‘no cue’ condition. Hence, there were four retrieval conditions that were repeated across the three presentation methods, giving in a total of twelve conditions: (1) the encoding position cues alone, (2) the visual background shape cues alone, (3) the encoding position cues with the background shape cues, and (4) the ‘no cue’ condition.

The results did show differential effects of the visual retrieval cues depending on the presentation method used at encoding and at retrieval. In the spatial-temporal condition, imagery performance was highest when both information about the visual background and the spatial-temporal order position during encoding were available as cues at retrieval. This was also the case in the spatial presentation method condition: presenting both the visual cue and the spatial position cue gave the highest performance. In both cases, performance was significantly poorer when no cue, the encoding position cue alone, or a visual cue alone was presented at retrieval. This indicates that verbal interference occurred during encoding and was attenuated by joint presentation of the relevant encoding position cue (i.e., the spatial-temporal order or spatial position cue) and the visual information. In the temporal presentation condition, the pattern of the results was different. The contrasting result was that the visual background cue with the temporal order position cue did not give an advantage over either no cue or the temporal position cue alone. Imagery performance in the latter two conditions was as high as the former one. This suggests that naming of the easy-to-name stimuli under the temporal presentation method did not lead to verbal interference. The visual background shape cue condition gave the lowest imagery performance. However, in the visual cue condition the temporal order in which the shapes were cued at retrieval was always incongruent with the temporal order in which the stimuli were presented at encoding. This incongruency in presentation order for this particular condition may account for the low performance in this condition, and perhaps suggests that access to temporal order information at retrieval was important for successful completion of the task.

Pelizzon et al. (2002) proposed that verbal interference did not occur in the temporal presentation condition. They implied that when spatial information was absent at encoding and at retrieval, participants had only temporal information to rely upon. Reliance upon temporal information may prevent spontaneous naming of the shapes. It was suggested that participants used their visual code to memorize the shapes and used the verbal code to memorize the order of the shapes (Pelizzon et al., 2002). They also suggested that the verbal code might have been used to link each item with the next item in the sequence. This might be the reason why interference occurred in the visual background shape cue condition, where participants could not use the link between the item and the following item in the sequence as a cue to retrieval as in this particular condition the shapes were cued in a different order to that presented during encoding.

The idea that the verbal code is used to memorize the order of shapes implied by Pelizzon et al. (2002) is supported by previous research. For example, Paivio et al. (1975) showed that remembering verbal items (words) was superior to remembering non-verbal items (pictures and environmental sounds) in serial recall while remembering non-verbal items was superior to remembering verbal items in free recall. This indicates that the verbal code is used to remember the items and their order (Paivio et al., 1975). In addition, Quinn and McConnell (2006) showed that remembering a list of items (words) in the temporal context is more successful when using verbal strategies (e. g., verbal rehearsal) compared to visual strategies (e. g., imaging the items) (see also Deffenbacher, Carr & Leu, 1981; Paivio & Csapo, 1969; Del Castillo & Gumenic, 1972). Similarly, Poirier et al. (2007) showed that participants' ability to reorder a memorized sequence of verbal labels was higher than their ability to reorder a sequence of line drawings. This reflects the use of the verbal code in memorizing not only the items but also their order. These findings are in common with the suggestion that the content of the verbal code is an important determinant of performance in the memory test and that this content may be mediated by the particular presentation method used when encoding and retrieving the stimulus. Under the temporal presentation method where verbal interference appears to be absent, the role of the verbal code however might not be exclusive to the encoding of the order of the shapes as suggested by Pelizzon et al., (2002). Other accounts may apply. It might be used to strengthen the encoding of the shapes (Ellis, 1968; Daniel & Toglia, 1976; Santa, 1975) by emphasizing the processing of semantic information (Ellis, 1968; Daniel & Toglia, 1976), or by unifying the visual features of the shapes into a single unit (the integrative account; Santa, 1975). The verbal code might, also, be linked with the visual representation during encoding so that it can be used to recall the visual representation as a whole at retrieval (Bahrick & Bahrick, 1971). It might, also, be used to memorize both the shapes and their order because the verbal code in the temporal presentation method decays slower than the visual code (Dainoff, 1970). These ideas related to the absence of verbal interference or the positive effects of spontaneous naming when using the temporal presentation method on visual memory are interesting, but are yet to be tested. Experiment 1, therefore, aimed to examine whether the presentation method at encoding and at retrieval moderates the effect of spontaneous naming in visual memory.

Experiment 1

Experiment 1 builds upon the findings from Pelizzon et al. (2002). It used two presentation methods: the temporal presentation method and the spatial-temporal presentation method. In this thesis, the method of presentation at encoding was always consistent with the method of presentation at retrieval, and hence, the term ‘presentation method’ always refers to the method of presentation at both encoding and retrieval. In addition, AS was manipulated during encoding and was compared with a ‘no AS’ (control) condition. Based on Pelizzon et al’s findings, it was expected that emphasising temporal order should not lead to verbal interference caused by the verbal coding of the shapes. It is suggested that this is due to useful information being encoded in the verbal code, such as information concerning temporal order that is useful during retrieval. If this is the case then inclusion of the AS condition during encoding should impair performance on the temporal presentation condition. This would be a novel result. In contrast, consistent with previous research in the imagery domain, it was expected that the verbal interference effect would be shown in the spatial-temporal presentation condition (Brandimonte et al., 1992a; Brandimonte et al., 1992b). This is the method of presentation predominantly used in previous research in the imagery domain. Thus, inclusion of the AS condition during encoding should improve performance on the spatial-temporal presentation condition because it can suppress the use of verbal coding. This positive effect of AS on the spatial-temporal presentation condition has been already shown by previous work (e.g., Brandimonte et al., 1992a; Brandimonte et al., 1992b).

Participants

Sixty healthy adults (39 females, 21 males), age ranged 17-38 (mean = 21 years and five months) were recruited at the University of Leeds. All participants had normal or correct-to-normal vision and were all native English speakers. All participants gave their informed consent prior to the experiment and were paid a small amount of money in return for their participation.

Materials

The stimuli included shapes, taken from the study by Brandimonte et al. (1992b). They were six easy-to-name shapes, and a new shape designed by the experimenter for the practice trial. When rotated a vertical angle (90 degrees) anti-clockwise, each shape makes two adjacent English capital letters, linked together. In some shapes, the two compounded letters share only one side. Brandimonte et al. described the shapes as nameable after asking 16 participants, who did not take part in their main experiment, to name the shapes. Easy-to-name shapes are those which were given the same name by 50% of the participants, while hard-to-name shapes are those which did not have significant agreement on their names. See Figure 2 for the easy-to-name shapes and their names agreed by Brandimonte et al's participants. For each shape, there were only two correct letters. See Table 1 for the correct answers for each shape, listed in the same order as used in Figure 2. The figures were drawn with black ink on white squared cards (measured 10 x 10 cm).

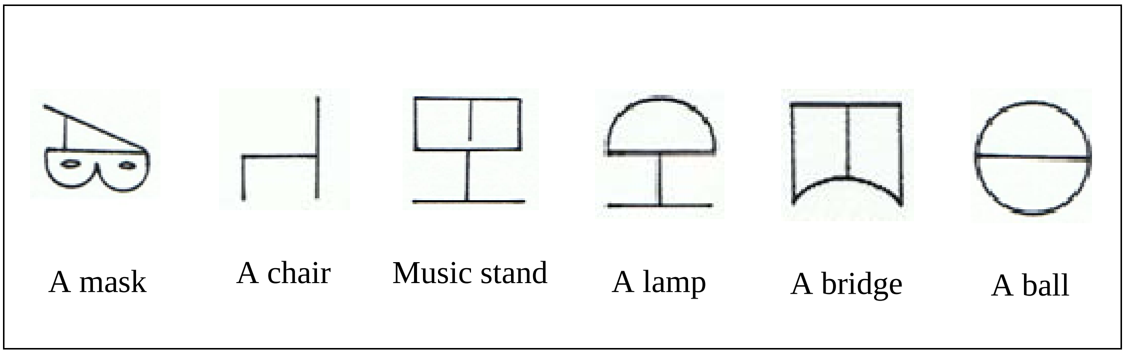


Figure 2. Easy-to-name shapes and their names, agreed by 16 participants (Brandimonte's et al., 1992a).

Reprinted from "Verbal Recoding of visual stimuli impairs mental image transformations," by M. A. Brandimonte, G. J. Hitch, and D. V. Bishop, 1992. *Memory & Cognition*, *20*, p. 450. Copyright 1992 by Springer Science & Business Media. Reprinted with permission. See Appendix A for the licence.

Table 1. Correct letters for easy-to-name shapes in the mental rotation paradigm.

Shape Type	*Shape*	*Correct Letters*
Easy-to-name Shapes	1	AB
	2	TL
	3	EH
	4	CH
	5	EC
	6	CD

Design and Procedures

A 2 (presentation method at encoding: spatial-temporal vs. temporal) x 2 (AS at encoding: AS at encoding vs. control) between-subject design was used. Each participant was randomly allocated to one of the four conditions, and each condition had 15 participants. Participants were tested individually in a session lasting about 10 minutes. The stimulus presentation followed the procedures used by Brandimonte et al. (1992b). Participants were shown the six easy-to-name shapes, presented sequentially (one at a time) in the same order three times, at a rate of five seconds for each shape. The participant therefore viewed each shape for 15 seconds, in total. The order of shape presentation varied across participants. In the spatial-temporal presentation condition, the cards were face down on the table in a row, and the researcher turned them over one by one. In the temporal presentation condition, the cards were presented in a single pile by hand in a sequential order. See Figure 3 for the spatial-temporal presentation method & Figure 4 for the temporal presentation method. Participants were asked to memorize the shapes, and were asked, after the presentation, to check in their minds that they were able to remember the shapes and their order. In the instance, they could not remember the shapes in their order; they were shown the shapes one more time. In this experiment, thirteen participants were shown the shapes, four times. In the AS at encoding condition, participants were asked to count out loud from 1-4 during the presentation of the stimuli. The experimenter ensured that they continued counting at a rate of two digits per second and did not stop until the presentation ended.

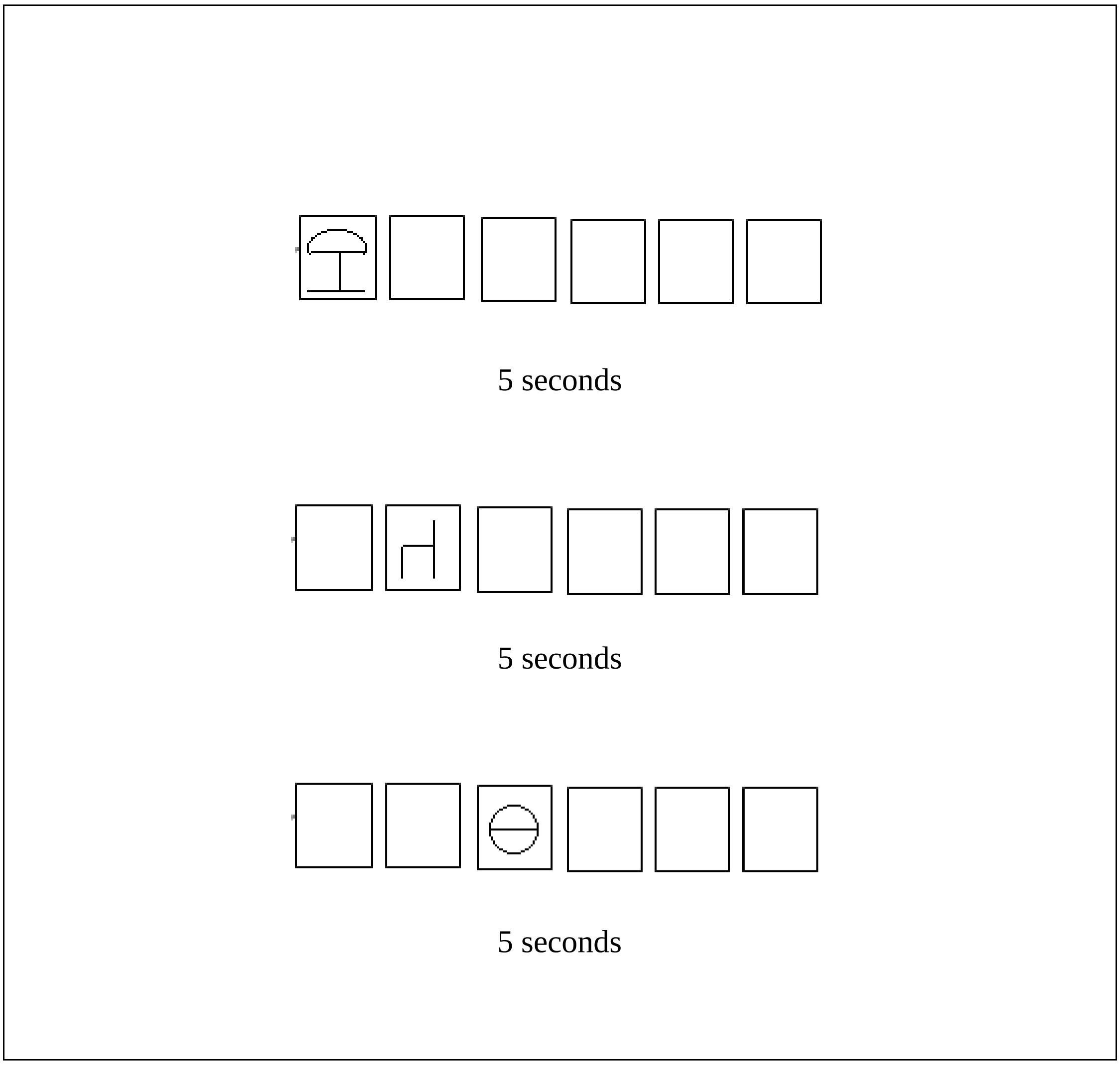


Figure 3. Illustration of how shapes were presented in the spatial-temporal presentation method.

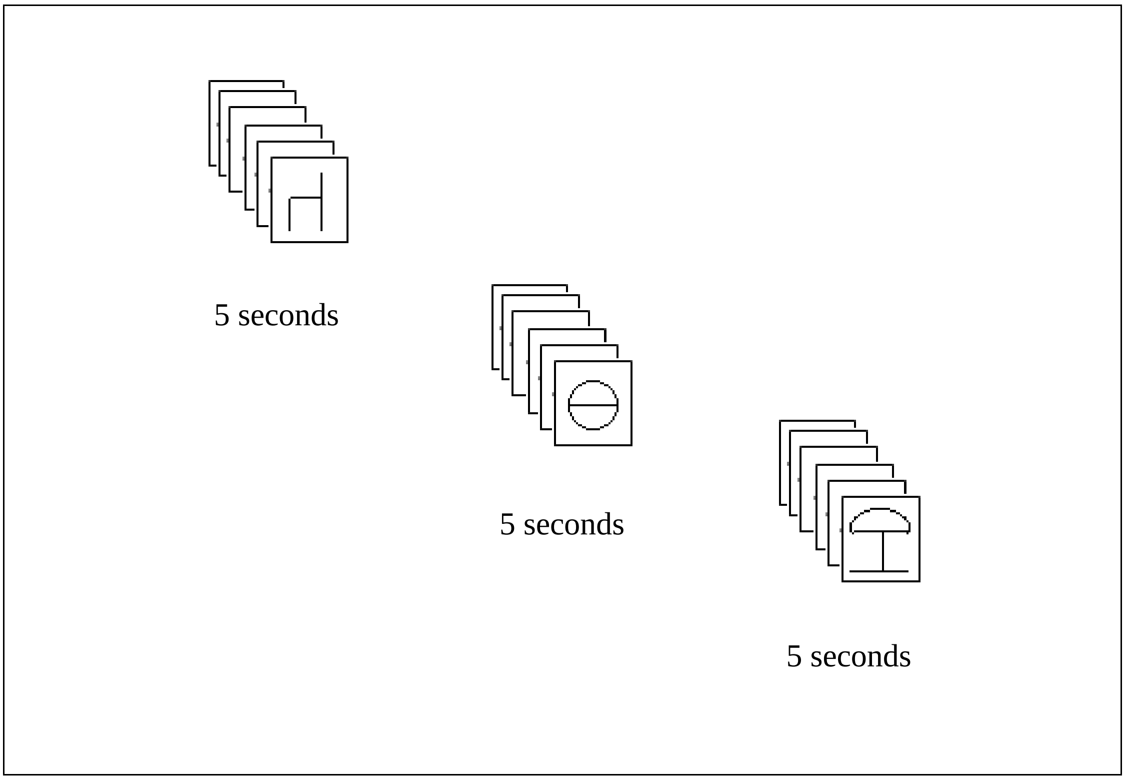


Figure 4. Illustration of how shapes were presented in the temporal presentation method.

After participants indicated that they could remember all the shapes, they were shown a training shape, and were told about the rotated letters. They were informed that all of the six shapes they memorized consisted of two embedded letters, and that the two letters are English capital letters joined together, and might share one line, but were never drawn inside each other. After they performed the training task, they were asked to recall the first shape, mentally rotate it 90 degrees counter clockwise, and say the two letters out loud. Then they continued with the rest of the shapes in their order. No time limit was included, and no feedback was given to participants during the experiment. In the spatial-temporal condition, the cards were left in their places face down on the table during the retrieval phase. In the temporal condition, the cards were removed from the view of participants at retrieval, and they were asked to recall the first shape, the second shape, and so on. After participants performed their tasks with all the shapes, they were debriefed about whether they had named the shapes to memorize them, and whether they had identified some of the embedded letters before they were told about them. In the temporal presentation conditions, all participants in the control condition reported that they named the shapes to memorise them while only eight participants in the AS condition reported naming strategies, and the remaining seven participants reported other strategies, such as drawing the shapes with their fingers and imaging them. In the spatial-temporal presentation condition, 12 participants in the control condition reported naming strategies, and three participants reported no strategies to memorize the shapes whereas eight participants in the AS condition reported that they named the shapes to memorize them, two participants reported no strategies, and five participants reported other visual strategies. No participants reported that they identified the letters before they were told about them.

Results

For each participant, a proportionally corrected score for each item was calculated by dividing the number of correct letters in each response by the number of possible correct answers. As there were two correct answers for each shape, participants' responses were scored as 0, .5, or 1 when they gave 0, 1, or 2 correct letters, respectively. Then, within each condition, participants' responses were pooled to provide a mean proportion correct score for each item. See Figure 5 for the means of proportionally corrected scores in each condition. Analyses by-participants provide a similar pattern of results, and therefore, are reported in Appendix B. However, it is highlighted when analyses by-items and analyses by-participants showed different pattern of results. Analyses by-participants are expressed by F^2. For Experiment 1 and all experiments in this thesis, the effect size was calculated using partial eta squared (η^2p). The effect size is considered small when η^2p is less than or equivalent to .01, medium when η^2p is less than or equivalent to .06 and large when η^2p is less than or equivalent to .14 (Cohen, 1988).

A one-way repeated measure ANOVA showed no significant effect of the presentation method, F (1, 5) = 2.15, p = ns, MSe = .01, η^2p= .3. Performance in the spatial-temporal presentation method was not significantly different (M = .47, SD = .1) from performance in the temporal presentation method (M = .41, SD = .11). No significant effect of AS at encoding was found, F (1, 5) = 3.64, p = ns, MSe = .007, η^2p= .42. Performance in the control condition (M = .48, SD = .11) was not significantly higher than performance in the AS at encoding condition (M = .41, SD = .12). A significant interaction was detected between the presentation method and AS at encoding, F (1, 5) = 9, p < .05, MSe = .007, η^2p= .64, but only by-items not by-participants, F^2 (1, 56) = 2.22, p = ns, MSe = .07, η^2p= .14.

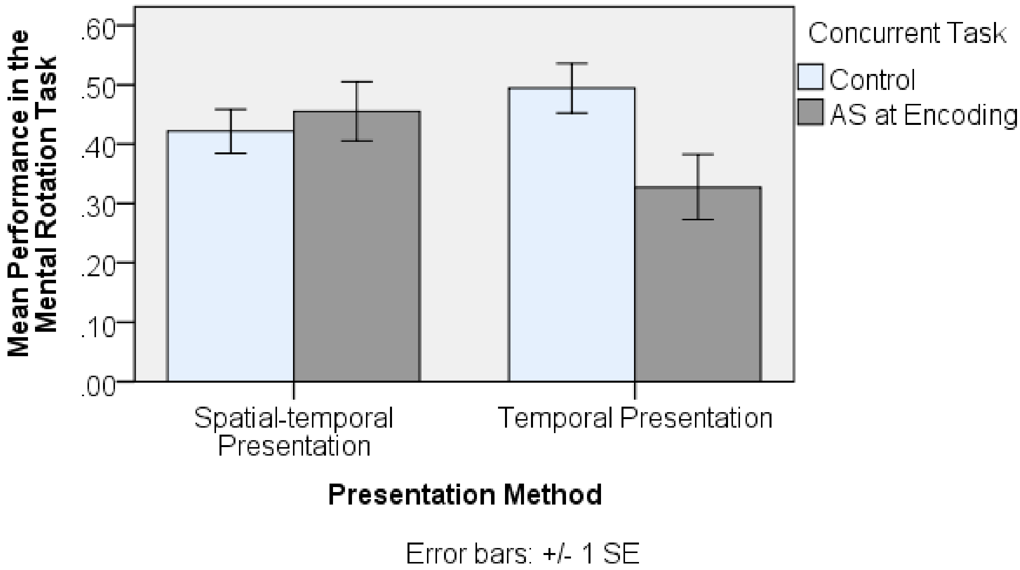


Figure 5. Performance in the rotation task in Experiment 1, expressed by the proportion correct score for items in each condition.

As AS at encoding was expected to impair performance on easy-to-name shapes in the temporal condition, further analyses examined the effect of AS compared to the control condition in the temporal presentation condition. A one-way repeated measures ANOVA shows significantly higher performance in the control condition (M = .49, SD = .1) compared to AS at encoding (M = .33, SD = .13), F (1, 5) = 6.25, p = .001, MSe = .001, $\eta^2 p$= .93. This pattern in the means was similarly obtained in the by-participants analysis, albeit the difference between performance in the control group (M =.49, SD =.23) and performance on AS at encoding (M =.33, SD = .26) was only marginally significant, F^2 (1, 28) = 3.45, p = .074, MSe = .06, $\eta^2 p$= .11.

In the spatial-temporal condition, a one way repeated measures ANOVA between control condition and AS at encoding showed no significant difference between performance in the control condition (M = .42, SD = .09) compared to AS at encoding (M = .46, SD = .12), F (1, 5) = 1.36, p = ns, MSe = .002, $\eta^2 p$= .214 (this was also the case by-participants, F^2 (1, 28) = .112, p = ns, MSe = .75, $\eta^2 p$= .004).

Discussion

The aim of Experiment 1 was to examine whether the presentation method at encoding and at retrieval mediates the effect of spontaneous naming within visual memory. The hypothesis was that spontaneous naming at encoding strengthens the encoding of the visual stimuli (Daniel & Toglia, 1976; Ellis, 1968) or encodes useful information, such as information concerning temporal order that is useful during retrieval (Poirier et al., 2007), when the temporal presentation method is used. In contrast, it has been already shown by previous research that spontaneous naming of the stimuli when using the spatial-temporal presentation method impairs performance within visual memory (Brandimonte et al., 1992a; Brandimonte et al., 1992b). Experiment 1 tested the effect of AS at encoding on the temporal presentation method and the spatial-temporal presentation method. The results showed a significant interaction between method of presentation and AS at encoding. This suggests a moderating effect of presentation method on the role of the verbal code within visual memory. AS at encoding in the temporal presentation condition impaired imagery performance, suggesting a positive effect of verbal encoding on visual memory. In the spatial-temporal presentation method, AS at encoding did not affect level of performance; performance was at the same level with and without AS at encoding. This latter finding was not expected, given the previous findings of Brandimonte et al. (1992a) where AS compared to no AS under spatial-temporal presentation conditions has led to improved performance. These findings are discussed in detail below.

Pelizzon et al. (2002) suggested that spontaneous naming at encoding in the temporal presentation method was used to memorize the order of the shapes and was not used to memorize the shapes themselves. This explanation is possible, implying that in this experiment, AS at encoding prevented the encoding of the order of the shapes. However, there are other explanations that can account for the negative effect of AS at encoding in the temporal presentation condition. Spontaneous naming may encode verbal information in conjunction with the visual information, which can be used at retrieval (Bahrick & Bahrick, 1971). Thus, AS at encoding prevents encoding of verbal information alongside the visual information, and hence, verbal information cannot be used at retrieval. A different explanation for the negative effect of AS at encoding on the temporal presentation method comes from the strengthening of encoding account. This suggests that the use of the verbal code strengthens the encoding of the shapes because it emphasizes semantic processing and, hence, improves visual memory of the shapes (Ellis, 1968; Daniel & Toglia, 1976). Based on this account, AS at encoding reduces emphasis on the semantic processing of the shapes and thereby impairs performance. Alternatively, the integrative account suggests that the use of the verbal code when encoding shapes put the features of the shapes into single visual units and, hence, improves visual memory of the shapes (Santa, 1975). Thus, AS at encoding prevented the integration of the features of the shapes into single visual units and thereby impaired performance. These accounts are examined in Experiment 2.

In the spatial-temporal presentation method, AS at encoding did not affect the level of performance. This finding was surprising, given that the verbal interference effect due to spontaneous naming has previously been found by Brandimonte et al. (1992a) when using a similar method of presentation. This might be due to the use of different strategies by participants when learning the shapes. It was expected that participants who performed AS at encoding would not use naming strategies to memorize the shapes. However, eight participants in the spatial-temporal presentation with AS at encoding condition reported naming the shapes to memorize them. However, this finding might suggest that when a stronger emphasis is put upon spatial information the use of the verbal code at encoding is less useful or, as shown by Brandimonte et al. (1992a), might lead to a disruption of performance. This is further examined in Experiment 3 (Chapter 3) of this thesis.

To conclude, spontaneous naming during the encoding of easy-to-name shapes when temporal information was emphasised during both encoding and retrieval had a positive effect on visual memory. On the other hand, the effect of spontaneous naming was less reliable in the spatial-temporal presentation method at encoding and at retrieval. The next step was (1) to replicate the finding of a positive role of verbalization when emphasising the temporal context during encoding; (2) attempt to place even greater emphasis upon spatial information during encoding and retrieval and; (3) to investigate the effect of AS at retrieval.

Chapter 3: Use of Verbal Information at Retrieval in the Mental Rotation Paradigm

Experiment 2

Introduction

The results of Experiment 1 imply that verbal encoding is useful under temporal presentation conditions, but less so under spatial presentation conditions. Experiment 2 addresses the question of (1) whether both easy- and hard-to-name shapes benefit from verbal encoding under temporal presentation conditions; and (2) whether access to the verbal code at retrieval is useful for performance under temporal presentation conditions.

Comparing two different types of shapes, easy-to-name shapes and hard-to-name shapes, has been used in spatial-temporal presentation conditions (e. g., Brandimonte et al, 1992a; Brandimonte et al, 1992b; Brandimonte et al, 1997). In such conditions, verbal manipulations such as AS had different effects on easy-to-name shapes and hard-to-name shapes. AS improved performance on easy-to-name shapes but had no effect on hard-to-name shapes (Brandimonte et al, 1992a; Brandimonte et al, 1992b). This was assumed to be because the nameability of the shapes mediated the use of the verbal code and the presence of the verbal code for easy-to-name shapes interfered with access to visual information useful for the imagery task. The idea that the use of the verbal code is useful for encoding the order of the shapes when they are presented in a pure temporal order can also be examined using AS at encoding with easy-to-name and hard-to-name shapes. If use of the verbal code was only related to the order of the shapes, then AS at encoding would impair visual memory of both easy-to-name and hard-to-name shapes. If the use of the verbal code was more related to the shapes than their order, for example, by deepening the level of processing of the shapes via the application of semantic processing (Ellis, 1968; Daniel & Toglia, 1976) or unifying the features of the shape into a single visual unit (Santa, 1975) then the effect of AS at encoding under the temporal presentation conditions would be mediated by the nameability of the shapes.

The researcher has obtained preliminary evidence that under temporal presentation conditions imagery performance on the mental rotation task is better for easy-to-name shapes compared to hard-to-name shapes. This was shown by an experimental comparison between performance in easy-to-name shapes and performance in hard-to-name shapes in the temporal presentation method. Performance was significantly higher for easy-to-name compared to hard-to-name shapes ([1]). This may imply that easy-to-name shapes compared to hard-to-name shapes benefit under temporal presentation conditions from the presence of spontaneous naming during encoding. One possibility for this is because easy-to-

---

([1]) Fifteen participants from the same population used in Experiment 1 performed the mental rotation task under the temporal presentation condition. They were healthy native English speakers (8 females, 7 males), age ranged 18-38 (mean = 24 years and four months). The stimuli were the six hard-to-name shapes, used by Brandimonte et al. (1992a). See Figure 6 in this chapter for the six hard-to-name shapes and Table 2 for the embedded letters in each shape. Participants performed the task without AS, and their performance was compared with performance on easy-to-name shapes without AS in the temporal presentation condition. A one way ANOVA between easy-to-name shapes and hard-to-name shapes showed a significantly higher performance for easy-to-name shapes (M = .49, SD =.23) compared to hard-to-name shapes (M = .32, SD = .19), F (1, 10) = 4.99, $p < .01$, MSe = .01, $\eta^2 p$= .5. This was, also, the case by-participants, F^2 (1, 28) = 4.97, $p < .05$, MSe = .06, $\eta^2 p$= .15. This suggests that easy-to-name shapes when presented in a temporal order had more benefits compared to hard-to-name shapes from the use of the verbal code, but it does not, necessarily, imply that hard-to-name shapes prevented the use of the verbal code.

name shapes are more closely related to the content of the verbal code (Mazard, Laou, Joliot & Mellet, 2005). AS under temporal encoding conditions may then introduce more impairing effects on the easy-to-name shapes compared to the hard-to-name shapes.

Experiment 1 showed that the use of the verbal code was beneficial at encoding under one type of condition, that is the temporal presentation condition. The role of the verbal code at retrieval has yet to be studied under temporal retrieval conditions. It was proposed to use AS at retrieval for this purpose. AS at retrieval has been shown to have no significant effects on performance in a mental reversal paradigm (Brandimonte & Gerbino, 1993). Brandimonte and Gerbino used reversible pictures (i. e., an example of this is the duck-rabbit picture, which is one of the bi-stable configurations that has two alternative interpretations, either a rabbit or a duck). Prior to the main experiment, participants had training on two pictures, where they were asked to look at each picture and to state the two possible interpretations for each picture. The pictures were left in sight of participants until they identified the two patterns or if they did not, the experimenter explained the two patterns, pointing to the features of each pattern. During the main experiment, participants were shown the picture (the duck-rabbit picture) for five seconds and were asked to retain a clear detailed image of it in their memory, but were not forewarned about the mental reversal task. The picture was easy-to-name and thus participants were expected to spontaneously name it with the first pattern they perceive. It was aimed at studying the effect of verbal encoding on later mental image reversal, and therefore, half of the participants were asked to perform AS during the presentation of the picture, preventing them from using their verbal code, and the rest of the participants were allowed to spontaneously name the picture. After removing the test picture from view, participants were asked to report the name of the picture they had just seen, and then were asked to generate a visual image of it and discover the other interpretation it contained. AS improved performance, where larger numbers of participants were able to perform the task in the AS condition compared to the no AS condition. In the same study, it was also aimed to study the effect of AS at retrieval on image reversal, and therefore, participants were involved in a similar mental reversal paradigm, and were asked to perform AS at encoding or AS at retrieval or were allowed to spontaneously name the picture in the control condition. The results showed, as with the previous finding, a higher performance for AS at the encoding condition compared to the control condition. Additionally, AS at encoding showed higher performance compared to AS at retrieval. Finally, AS at retrieval and the control condition did not differ significantly from each other. These findings showed that both AS at retrieval and the control condition were impaired by spontaneous naming at encoding. In contrast, the verbal code was of little importance at retrieval in the mental reversal paradigm, and therefore, suppressing its use through AS at retrieval did not improve performance compared to the control condition. However, an important difference between the mental reversal study and this current study was that the mental reversal study showed a positive effect of AS at encoding, reflecting verbal interference. In contrast, in this current research, the findings from Experiment 1 showed that the verbal code benefited memory because of the temporal presentation method. Hence, the role of the verbal code at retrieval in the present study was expected to differ from that in the mental reversal paradigm.

The positive role of the verbal code has yet to be specified in the temporal presentation method. If the verbal code was used to encode and retrieve the temporal order of the stimuli (Pelizzon et al., 2002) or was combined with visual information and used to serve as a cue to retrieve each shape as a whole (Bahrick & Bahrick, 1971), then participants would need to rely on the verbal code to retrieve the shapes in the temporal condition. AS at retrieval would then impair performance in the task. However, if the verbal code was used to unify the features of each shape into a single visual unit and was not involved at retrieval of the shapes (Santa, 1975), then this would not show the negative effect of AS at retrieval. Similarly, if verbal information was used to strengthen the encoding of the shapes by encouraging the use of deeper semantic processing, but was not used to access visual information whilst retrieving the shapes (Daniel & Toglia, 1976), then this would not make the verbal information useful at retrieval, and this would not show the negative effect of AS at retrieval.

AS is one of the most common concurrent tasks used to disrupt the use of the verbal code and is understood in light of the working memory model. According to Baddeley and Hitch (1974), working memory is supported by two specialized systems: the phonological loop for verbal information and the visual-spatial sketch pad for visual and spatial information. The visual-spatial sketch pad is separate from the phonological loop (Logie, Zucco & Baddeley, 1990). Once the verbal code is suppressed, people might rely on their visual and spatial information. AS is an active rehearsal process, which blocks rehearsal, and prevents verbal recoding of visually encountered stimuli. Thus, it is expected to block the use of the verbal code. Nevertheless, this active vocalization of an irrelevant sound might also block verbal processes other than accessing stored verbal information, such as identifying English letters from the alphabet which is necessary for the mental rotation task used here. For this reason, another concurrent task was used for comparison with AS at retrieval; the preload task. This involves maintaining a new sequence of digits during performance of the visual task, and then recalling the sequence after the visual task. Maintaining and even silent rehearsal of auditory digits is a pure verbal task which does not interact with visual processing, particularly when the digit sequence is small (Morey & Cowan, 2004; Cocchini, Logie, Della Sala, MacPherson & Baddeley, 2002; Baddeley & Hitch, 1974). It was aimed to compare the effect of the preload task of three-digit sequences with the effects of the typical AS at retrieval. The preload task does not involve active rehearsal of the digits, and would not be expected to interfere with processing such as identifying English letters. If AS at retrieval impaired identification of English letters then, AS at retrieval is expected to exert greater interference than the preload task. The control condition did not involve performing an additional concurrent task (e.g., a desk tapping task). This is because such tapping tasks might involve spatial elements (Emerson & Miyake, 2004). These spatial elements might interfere with the demands of the primary task when participants were required to memorize the spatial locations of the shapes (e.g., Experiment 1 and 3). Therefore, a control condition, which did not involve an additional concurrent task, was chosen. Such control conditions were consistently used in visual imagery paradigms to be compared with AS conditions (e.g., Brandimonte et al., 1992a; 1992b; Brandimonte & Gerbino, 1993; Pelizzon et al., 1999).

In order to examine the above hypotheses, Experiment 2 used a new version of the mental rotation paradigm, introducing a computer based test. The computer-based paradigm, which can achieve more accuracy and control in administration and analyses of the data (Zandvliet & Farragher, 1997 as cited in Noyes & Garland, 2008), was tested to see whether it replicated the results of the paper-based experiment. Experiment 2 used the temporal presentation method for all conditions.

AS at encoding was used to replicate the findings of Experiment 1, which used easy-to-name shapes, and to confirm the suggestion that the use of the verbal code is useful under the temporal presentation method. This would show a lower performance in the AS at encoding condition compared to the control condition in the experiment, where no concurrent task was used.

Additionally, it compared performance on easy-to-name and hard-to-name shapes and used concurrent verbal tasks on both easy-to-name and hard-to-name shapes. If the verbal code benefits imagery performance then it was expected to find overall higher performance for easy-to-name shapes, which are assumed to be spontaneously named, compared to performance on hard-to-name shapes, where spontaneous naming is not expected to occur (preliminary evidence for this had already been established, see footnote 1 in page 69). Additionally, if the concurrent tasks had a differential effect on each shape type, this would imply that the role of the verbal code is mediated by the nameability of the shape. This would be reflected by the concurrent tasks exerting more impairment on easy-to-name shapes, which might benefit more from the verbal code under temporal conditions, compared to that on hard-to-name shapes. This would show a significant interaction between the effect of shape type and the effect of the concurrent tasks. If the concurrent tasks had the same effect on both types of shapes, this would suggest that the verbal code is not related to the type of shapes but is more relevant to the order of shapes. It would, also, suggest that the overall higher performance on easy-to-name shapes compared to hard-to-name shapes is related to other factors rather than the use of the verbal code; including concreteness and semantic information. This would be reflected by a main effect of the concurrent tasks on both types of shapes.

AS at retrieval was used to further specify the role of the verbal code at encoding. Verbal information may be useful at retrieval to cue visual information (Bahrick & Bahrick, 1971; Pelizzon et al., 2002). If verbal information is involved at retrieval to cue the shapes, then AS at retrieval would impair performance. This would be reflected by a lower performance in the AS at retrieval condition compared to the control condition.

Finally, the preload task was added to be compared with AS at retrieval. If AS at retrieval and the preload task at retrieval had the same effect on memory performance, then this would mean that the two tasks were successful in suppressing the use of the verbal code, and the observation of AS effects would not be attributable solely to disruption of letter identification. If AS at retrieval did not only suppress the use of the verbal code but also impaired identifying the English letters, then differential effects would be found between AS at retrieval and the preload task at retrieval. This would be reflected by showing a significantly higher performance for the preload condition at retrieval compared to AS at retrieval.

Participants

One hundred and twenty healthy adult, native English speakers (81 females, 39 males), age-ranged 18-40 (mean = 22 years and 5 months), were recruited from the University of Leeds and the University of York. All participants had normal or corrected to normal vision and had not participated in the previous experiment. All participants gave their informed consent prior to the experiment, and obtained a small amount of money in return for their participation.

Materials

The stimuli for the mental rotation task were taken from Brandimonte et al (1992b). They included six easy-to-name shapes and six hard-to-name shapes. The easy-to-name shapes were the same as those used in Experiment 1, and the hard-to-name shapes were used as a subsidiary comparison after Experiment 1 (see footnote 1 in page 69). As mentioned in Chapter 2, Brandimonte et al. used a nameability agreement test to classify the shapes. Shapes which received 50% agreement on their names were classified as easy-to-name shapes, and shapes which received less than 50% agreement on their names were classified as hard-to-name shapes. The only change applied is that they were presented on a 16 inch white computer screen, where each shape appeared as a black drawing, approximately 12 cm height x 12 cm width, in the centre of the screen. No borders were drawn around the figures, so they appeared on a larger white background.

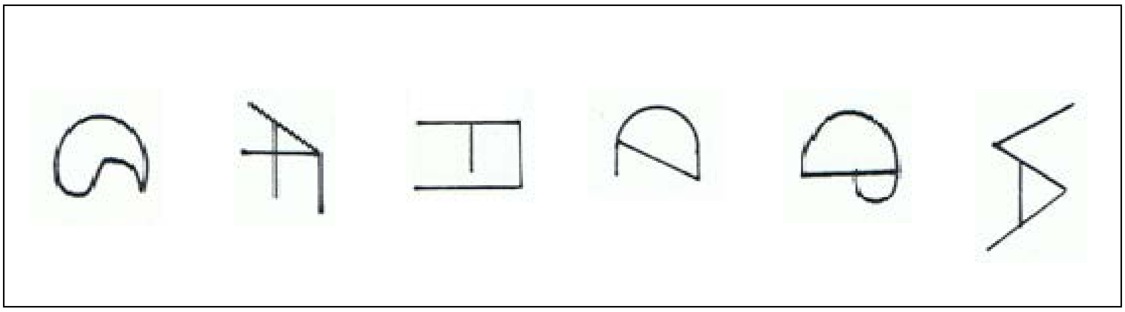


Figure 6. Hard-to-name shapes drawn by Brandimonte et al. (1992a).

Reprinted from "Verbal Recoding of visual stimuli impairs mental image transformations," by M. A. Brandimonte, G. J. Hitch, and D. V. Bishop, 1992. *Memory & Cognition, 20,* p. 450. Copyright 1992 by Springer Science & Business Media. Reprinted with permission. See Appendix A for the licence.

Table 2. Correct letters for hard-to-name shapes in the mental rotation paradigm.

Shape Type	*Shape*	*Correct Letters*
Hard-to-name Shapes	1	CS
	2	AF
	3	FI
	4	CZ
	5	CP
	6	VA

Materials for a concurrent preloading verbal task contained six auditory series, in addition to a practice series. Each auditory sequence consisted of three different digits, presented through headphones at a rate of one digit per second.

Design and Procedures

The design was a 2 (shape type: easy-to-name vs. hard-to-name) x 4 (concurrent task: control condition, AS at encoding, AS at retrieval, and preload at retrieval) between-subject factorial design. Participants were randomly assigned to one of the eight groups, each group had 15 participants. Participants were tested individually in a session lasting about 10 minutes. The stimulus presentation followed the procedures used by Pelizzon et al. (2002) and applied in Experiment 1, but were presented on a laptop screen and controlled by E-prime V.2 software to control the presentation duration. Six shapes were presented sequentially, at a rate of five seconds for each figure, and a one second blank interval screen preceded each shape. The presentation was repeated three times, in the same order for all three presentations, and an interval screen was exposed before each presentation, asking participants to press the SpaceBar to view the presentation again. The order of shapes varied between participants. Participants were asked to memorize the shapes in their correct order and were not told about the hidden letters. After the presentation was completed, they were asked to think about whether they could remember the shapes with 100% accuracy. All participants (except three) reported being able to do so. In case participants were not able to memorize the shapes, they were shown the presentation again. Participants in all conditions, except the AS at encoding condition, were presented with the shapes under the same condition. In the AS at encoding condition, participants were asked to count out loud continuously from one to four while viewing the shapes. They were asked to start counting as soon as they pressed the SpaceBar to view the shapes and to not stop counting unless the presentation terminated.

After the presentation, participants were shown a training shape, which consisted of two embedded letters, followed by the same shape rotated 90 degrees counter clockwise, and their attention was directed to the two letters. At that stage, they were informed that all the six shapes they had learned were made of two English capital letters joined together, and that their task was to recall each shape, mentally rotate it 90 degrees counter clockwise and identify the two letters.

Participants, in the relevant condition, were then informed about the concurrent task and were able to practice it using the same training shape. Then participants did the rotation task with the six shapes in order (i. e. first shape = first trial, and so on). In the control condition and articulatory suppression at encoding condition, a fixation cross was exposed in the centre of the screen for five seconds, at the beginning of each trial. Participants were asked to wait and to not start the rotation task until they heard a tone. After the tone, they performed the rotation task, typed the two letters, and then pressed the SpaceBar to move to the next trial. In the

AS at retrieval condition, participants were asked to do the rotation task simultaneously with counting out loud from one to four repeatedly and continuously, at a rate of two digits per second. They started counting after the tone of each trial, continued counting, and did not pause until they identified the letters and typed them. In the preload task, participants did not see a fixation cross at the beginning of each trial; instead, they heard a sequence of three digits before the tone. After the tone, they performed the rotation task, and then said the digits out loud. All participants were allowed to spend as much time as needed on each trial. In the case that participants could not identify the letters, they were told to press the return key on the keyboard. The five-second fixation cross was inserted at the beginning of each trial in the control and the AS conditions in order to resemble the time period given over to presenting the to be remembered numbers for the preload task. After participants performed their tasks with all the shapes, they were debriefed about whether they named the shapes in order to memorize them, and whether they had identified some of the embedded letters before they were told about them. All participants in the easy-to-name conditions had named the shapes to memorize them, and had not identified the letters before they were told about them. Participants in the hard-to-name conditions used combinations of strategies to memorize the shapes (e. g., naming, dividing shapes, matching with similar items, etc.), and four participants out of sixty participants identified the letters before they were told about them. Participants who identified all the letters during the presentation phase were eliminated from the study and were replaced by new participants.

Results

Performance in the mental rotation task. As there were two correct answers for each shape, participants' responses were scored as 0, .5, or 1 when they gave 0, 1, or 2 correct letters, respectively. Then within each condition participants' responses were pooled to provide a mean proportion correct score for each item. See Figure 7 and Table 3 for the means of proportionally correct scores for each condition. Analyses by-participants provided a similar pattern of results, and therefore, are reported in Appendix C. However, it is highlighted when analyses by-items and analyses by-participants showed different pattern of results. Analyses by-participants are expressed by F^2.

A 2 (shape type: easy-to-name vs. hard-to-name shapes) between group x 4 (concurrent task: control, AS at encoding, AS at retrieval, and preload) within group mixed factorial design analysis of variance (ANOVA) revealed a significant main effect of the shape type on participants performance in the rotation task, F (1, 10) = 12.04, $p < .01$, *MSe* =, 01, $\eta^2 p$= .55. Performance for easy-to-name shapes, which are spontaneously verbalized by participants, (*M* = .37, *SD* = .13) was higher than performance for hard-to-name shapes (*M* = .25, *SD* = .1). The main effect of concurrent tasks, control (*M* = .43, *SD* = .14), AS at encoding (*M* = .21, *SD* = .07), AS at retrieval (*M* = .3, *SD* = .07), and preload at retrieval (*M* = .29, *SD* = .11), on performance in the rotation task was significant, F (3, 30) = 21.75, $p < .001$, *MSe* = .005, $\eta^2 p$= .69. The effects of the concurrent tasks did not interact with the shape type, F (3, 30) =1.05, p = ns.

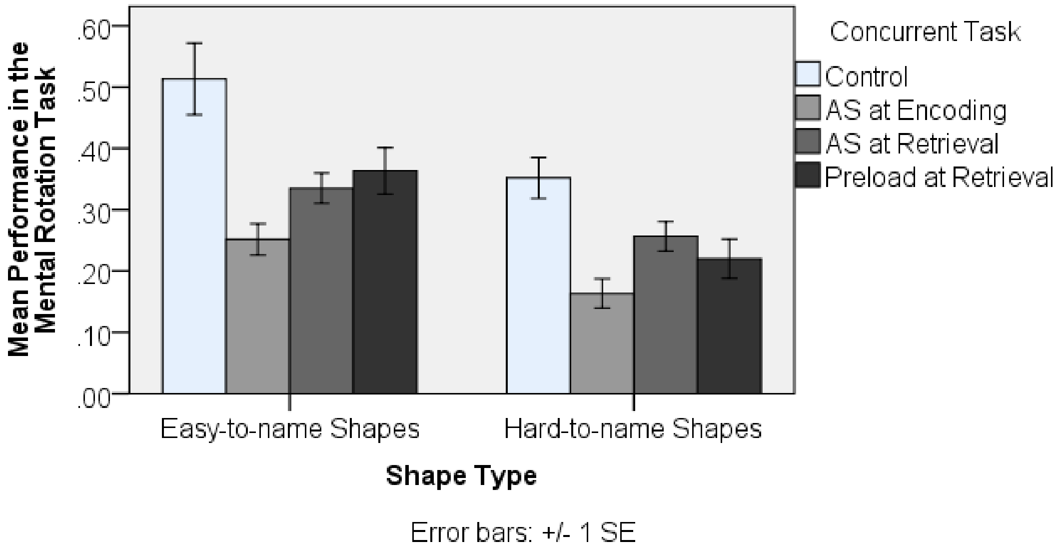


Figure 7. Performance in the rotation task in Experiment 2, expressed by the proportion correct score for items in each condition.

Table 3. Means and standard deviations for each condition in Experiment 2.

Shape Type	*Concurrent Task*	*Mean*	*Standard Deviation*
Easy-to-name shapes	Control	.51	.14
	AS at encoding	.25	.06
	AS at retrieval	.34	.06
	Preload at retrieval	.36	.09
Hard-to-name shapes	Control	.35	.08
	AS at encoding	.16	.06
	AS at retrieval	.26	.06
	Preload at retrieval	.22	.08

Further analyses compared the control condition with each of the concurrent task conditions. Post hoc comparisons using the Tukey HSD test indicated that performance for the control condition (M = .43, SD = .14) was significantly higher than the AS at encoding condition (M = .21, SD = .07), $p < .001$. Additionally, the control condition (M = .43, SD = .14) was significantly higher than the AS at retrieval condition (M = .3, SD = .07), $p < .01$ (although this effect was not significant by-participants, p = ns). Finally, performance for the control condition (M = .43, SD = .14) was significantly higher than the preload at retrieval condition (M = .29, SD = .11), $p < .001$ (although this effect was not significant by-participants, p = ns). All the remaining comparisons between the concurrent verbal tasks were not significant.

Difference scores were explored by calculating the differences in the means between the control condition and each of the concurrent task groups. A 2 (shape type: easy-to-name vs. hard-to-name shapes) between group x 3 (the size of the difference between the control condition and each concurrent task: AS at encoding, AS at retrieval, and preload) within group mixed factorial design analysis of variance (ANOVA) revealed a significant main effect of the shape type on the size of differences of the concurrent tasks, F (1, 10) = 30.11, $p < .001$, MSe =, 01, $\eta^2 p$= .75. The size of differences for easy-to-name shapes (M = .20, SD = .14) was larger than the size of differences for hard-to-name shapes (M = .14, SD = .08) (however, the main effect of shape type by-participant analyses was not significant, F^2 (1, 84) = .42, p = ns, MSe = .1, $\eta^2 p$= .01). The main effect of concurrent tasks AS at encoding (M = .23, SD = .11), AS at retrieval (M = .14, SD = .12), and preload at retrieval (M = .14, SD = .12), on performance in the rotation task was significant, F (2, 20) = 9.99, $p < .001$, MSe = .003, $\eta^2 p$= .5 (however, this effect was not significant by-participants, F^2 (2, 84) = .92, p = ns, MSe = .1, $\eta^2 p$= .02). The effects of the concurrent tasks did not interact with the shape type, F (2, 20) =1.22, p = ns. Post hoc comparisons using the Tukey HSD test did not show a significant difference between the size of differences for AS at encoding (M = .23, SD = .11) and AS at retrieval (M = .14, SD = .12), p = ns. Additionally, there was no significant effects of the size of differences for AS at encoding (M = .23, SD = .11) and the size of differences for preload at retrieval (M = .14, SD = .12), p = ns. Finally, the size of differences for AS at retrieval (M = .14, SD = .12) was not significantly different from preload at retrieval (M = .14, SD = .12), p = ns.

Performance in the digit recall task. In the digit recall task, used in the preload condition, participants were expected to recall the digits in their correct order, and they were given one score for each digit retrieved in the correct position. The mean number of digits correctly recalled per sequence was calculated in order to examine whether participants were able to do the task. As there were three digits in each sequence, the maximum score for each participant was 3. Performance on the digit recall was close to the ceiling level while retrieving the easy-to-name shapes (*M* = 2.74, *SD* = 0.38) and while retrieving hard-to-name shapes (*M* = 2.82, *SD* = 0.34), and no significant difference was found between the two conditions, $t(28) = 1.551$, p = ns.

Discussion

Experiment 2 extended the mental rotation paradigm to a computer based test. For easy-to-name shapes it replicated the negative effect of AS at encoding in the temporal presentation method previously found in Experiment 1, and it extended this effect to hard-to-name shapes. Additionally, it examined how AS and the preload task at retrieval affect performance in the temporal context. It showed that both AS and the preload task at retrieval impaired performance in mental rotation. This suggests that the role of the verbal code is important for successful encoding and successful retrieval of both easy- and hard-to-name shapes in the temporal presentation conditions.

The results showed no interaction between the concurrent tasks and shape type. This suggests that the concurrent tasks impaired memory performance for both easy-to-name and hard-to-name shapes, to a similar extent across both types of shapes, either at encoding or at retrieval. This might suggest that the role of the verbal code is related to encoding the order of the shapes, and is independent from the nameability of the shapes (Pelizzon et al., 2002). However, easy-to-name shapes had better imagery performance overall than hard-to-name shapes, though there are likely to be other differences between these shape sets other than likelihood to verbalise, including familiarity, memorability, concreteness, and imageability, that may contribute to differences in performance.

Both AS and the preload task at retrieval impaired performance compared to the control condition across both easy-to-name and hard-to-name shapes. This suggests that when verbal codes were suppressed, visual retrieval was impaired. This implies that verbal codes can be used at retrieval to access existing representations of the visual shapes and perform the rotation task. Additionally, it was suggested that AS at retrieval might block participants' ability to identify the English letters rather than their ability to recall the shapes because AS involves active vocalization. AS at retrieval could be splitting attention during image manipulation between vocalisation and a demanding imaging task, resulting in a general detriment to memory performance. This argument may not apply to the preload condition as participants were not concurrently actively carrying out another task whilst manipulating the image. However, the results showed an equivalent effect of AS and the preload task at retrieval. This implies that AS at retrieval blocked participants' ability to recall the shapes and not their ability to identify the English letters.

An explanation of the impairment in performance in the rotation task by AS and the preload task at retrieval was that the verbal code serves as a cue to retrieve each shape as a whole (Bahrick & Bahrick, 1971), and, therefore, verbal suppression produces a reduction in performance accuracy because of the absence of the cues in retrieval. Additionally, it might be suggested that the verbal codes play a role in serial position recall and not in the recall of visual items (Pelizzon et al, 2002). These suggestions are consistent with the findings of equivalent impairment by the concurrent tasks for both easy-to-name and hard-to-name shapes. They indicate that the role of the verbal code is not related to encoding features integral to the shapes and, therefore, is more related to order processing.

The nature of the AS task. The AS task used in Experiment 1 and this experiment required counting out loud from one to four. This task was chosen because it was suggested that AS should take a form of repeating one syllable or an overlearned digit sequence. Some concurrent tasks, such as counting backwards (Glanzer, Dorfman & Kaplan, 1981) and the random generation of letters or digits (Baddeley, 1986; Gilhooly, Logie, Wetherick & Wynn, 1993), load not only on the phonological loop but also on central executive control. However, an issue might be raised here regarding the use of a suppression task involving the repetition of a number sequence while the task requires memorizing the order of the stimuli. One might suggest that AS impaired performance of a sequence of shapes because the repeated numbers interfered with the ability to verbally code the order of the shapes in a numerical form. Examination of this issue requires the use of an AS task at encoding that involves repeating one syllable to be compared with a task involving counting (i.e., from 1-4 as was the case here). If AS at encoding interfered with the task because of the use of sequential digits, then using the syllable ‘la’ instead of the digits would remove the negative effect of AS at encoding on performance. In order to rule out this concern about the nature of the AS task, a new condition was added to the experiment. A group of 15 participants (10 females, 5 males), who were adult native English speakers, age ranged 17-38 (mean = 25 years, and 11 months) performed the mental rotation task with AS at encoding, using the syllable ‘la’. The method of the experiment was exactly the same as the computer-based temporal presentation experiment. The results from item analyses by a one-way repeated measure ANOVA showed that performance in the control condition, (M = .51, SD = .05) was significantly higher than performance in the AS at encoding condition (M = .34, SD = .06), F (1, 5) = 6.939, $p < .05$, MSe = .012, $\eta^2 p$= .58. The analyses by participants also showed a significant impairment by the AS at encoding compared to the control condition, F (1, 28) = 6.839, $p < .05$, MSe = .05, $\eta^2 p$= .2. These findings show that repeating one syllable, similar to counting, can suppress the use of the verbal code and impair imagery performance in the temporal presentation method. Hence, it is unlikely that the negative effect of AS, which used counting from one to four, in Experiment 1 and 2 is a result of suppressing participants' ability to encode the order of the shapes in a numerical format.

To conclude, Experiment 2 achieved methodological aims, including extending the mental rotation paper-based paradigm to a computer-based paradigm. Additionally, it showed the reliability of the preload task in suppressing the use of the verbal code at retrieval. Experiment 2 also built on the findings of Experiment 1. It showed that once the verbal code is emphasized at encoding it becomes useful at retrieval. This was shown by finding a negative effect of the concurrent verbal tasks at retrieval on both easy-to-name and hard-to-name shapes. These findings are consistent with the conjoint encoding of verbal and visual information account by which the verbal information is thought to be used to cue access to visual representations at retrieval (Bahrick & Bahrick, 1971). In contrast, these findings may rule out the idea that the verbal code is only used to strengthen the encoding of the shapes. The strengthening of encoding theory suggests that the verbal encoding is only required to encode the stimulus and is not required for retrieving the stimulus (Daniel & Toglia, 1976; Ellis, 1968; Santa, 1975). Therefore, this account cannot be applied to the finding that the verbal code was useful at retrieval. Additionally, Experiment 2 showed that concurrent verbal tasks were equivalently harmful for encoding and retrieving both easy-to-name and hard-to-name shapes. This suggests that concurrent verbal tasks at encoding and at retrieval may have been found due to the disruption of order processing (Poirier et al., 2007; Pelizzon et al., 2002), and that the role of the verbal code may not be related to the aspects integral to the shapes, such as semantic information.

Experiment 3

Introduction

Experiment 1 implied that spontaneous verbal encoding is less reliable under spatial-temporal presentation. It showed no significant difference between performance in the AS at encoding condition and the control condition in the mental rotation task. This finding contradicted those of Brandimonte et al., (1992a), who showed higher performance for their AS at encoding condition compared to the control condition (i.e., where there was no AS) using the spatial-temporal presentation method. This discrepancy between the findings of Experiment 1 and those of Brandimonte et al. might be due to the different strategies used by participants in learning the shapes.

Experiment 3 aimed to place greater emphasis upon spatial information. The aim of this experiment was two-fold: (1) to emphasize the encoding and retrieving of the spatial locations of the shapes and (2) to test the effects of the concurrent tasks at encoding and retrieval of the shapes. Therefore, the experiment used a new spatial presentation method designed to de-emphasize the use of temporal information. Additionally, it had three conditions: the control condition, AS at encoding, and preload at retrieval. AS at retrieval was not used in Experiment 3 because Experiment 2 showed a similar effect of AS and the preload task at retrieval in suppressing the use of the verbal code. If emphasizing spatial information at encoding and retrieval of the shapes reduced the reliance on the verbal code, then no significant difference would be found between the control condition and the concurrent verbal task conditions.

Participants

Forty five healthy adults, (32 females, 13 males), age-ranged 18-40 (mean = 22 years and 9 months), were recruited from the University of Leeds. All participants had normal or correct-to-normal vision, were native English speakers, and had not participated in any of the previous experiments that used the mental rotation paradigm. All participants gave their informed consent prior to the experiment, and were paid a small amount of money or course credit in return for their participation.

Materials

The shapes were the six easy-to-name shapes, which were used in the above experiments. Each shape was drawn inside a 5 x 5 cm square, and all the shapes were presented as black drawings on a 16 inch white computer screen.

Design and Procedures

There were three conditions: control condition, AS at encoding, and preload at retrieval. The design was a between-subjects factorial design. Participants were randomly assigned to one of the three groups, each had 15 participants. The dependent variable was the number of letters correctly identified. The procedure followed the procedure of Experiment 2 with the following modifications. During the stimulus presentation, six squares appeared around the screen in fixed locations, and each of the six shapes was assigned to one of the six squares. The presentation had three rounds. In each round, each shape appeared in its square for five seconds and, then, disappeared, and another shape appeared in a different square. The order of the shapes was varied across the three rounds, and the order was varied across participants. See Figure 8 for the encoding phase in the spatial presentation method. Participants were asked to memorize the figures and their locations.

In the retrieval phase, participants did the rotation task with the six shapes in a different order from the orders the shapes were originally presented to them. In the control condition and AS at encoding condition, a fixation cross was exposed in the centre of the screen for five seconds, at the beginning of each trial. Participants were asked to wait and to not start the rotation task until they heard a tone. After the tone, six empty squares appeared in the locations they were presented in the encoding phase, and the square of the shape that the participant had to recall was highlighted with red. In the preload task, participants did not see a fixation cross at the beginning of each trial; instead, they heard a sequence of three digits before the tone. After the tone, they performed the rotation task, and then said the digits out loud. After participants performed their tasks with all the shapes, they were debriefed about whether they had identified the embedded letters before they were told about them. All participants had not identified the letters before they were told about them.

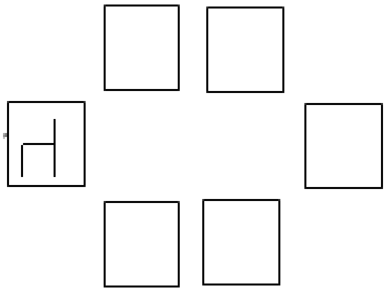
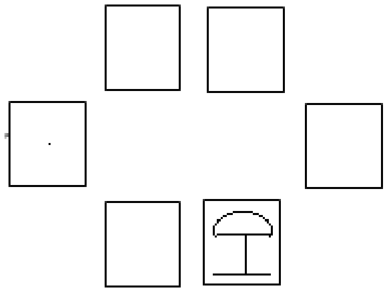
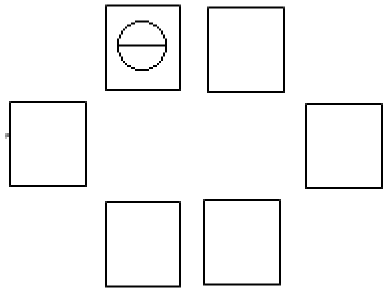
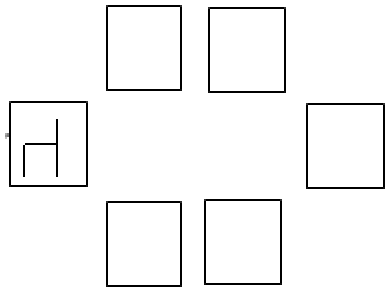
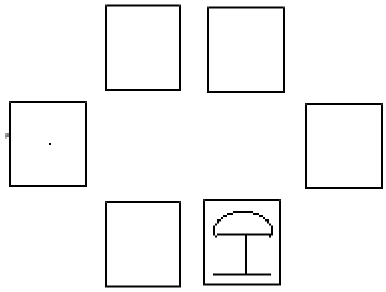
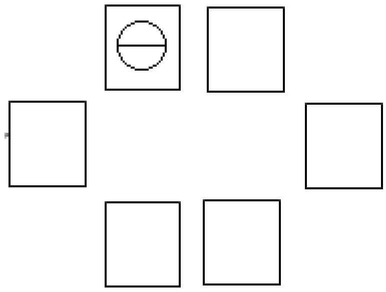
Round 1 of Presentation	Round 2 of Presentation
 Screen 1: 5 seconds	 Screen 1: 5 seconds
 Screen 2: 5 seconds	 Screen 2: 5 seconds
 Screen 3: 5 seconds	 Screen 3: 5 seconds

Figure 8. Illustration of how the shapes were presented in the spatial presentation method.

Results

Performance in the mental rotation task. As there were two correct answers for each shape, participants' responses were scored as 0, .5, or 1 when they gave 0, 1, or 2 correct letters, respectively. Within each condition participants responses were then pooled to provide a mean proportion correct score for each item. See Figure 9 for the means of proportionally correct score for each condition. Analyses by-participants provided a similar pattern of results, and therefore, are reported in Appendix D. However, it is highlighted when analyses by-items and analyses by-participants showed different pattern of results. Analyses by-participants are expressed by F^2.

A one way repeated measure ANOVA between the control condition (M = .47, SD = .14), AS at encoding (M = .41, SD = .1) and preload at retrieval (M = .41, SD = .15) revealed no significant effect of the concurrent tasks, F (2, 10) = 1.26, p = ns, MSe = .01, η^2p = .2.

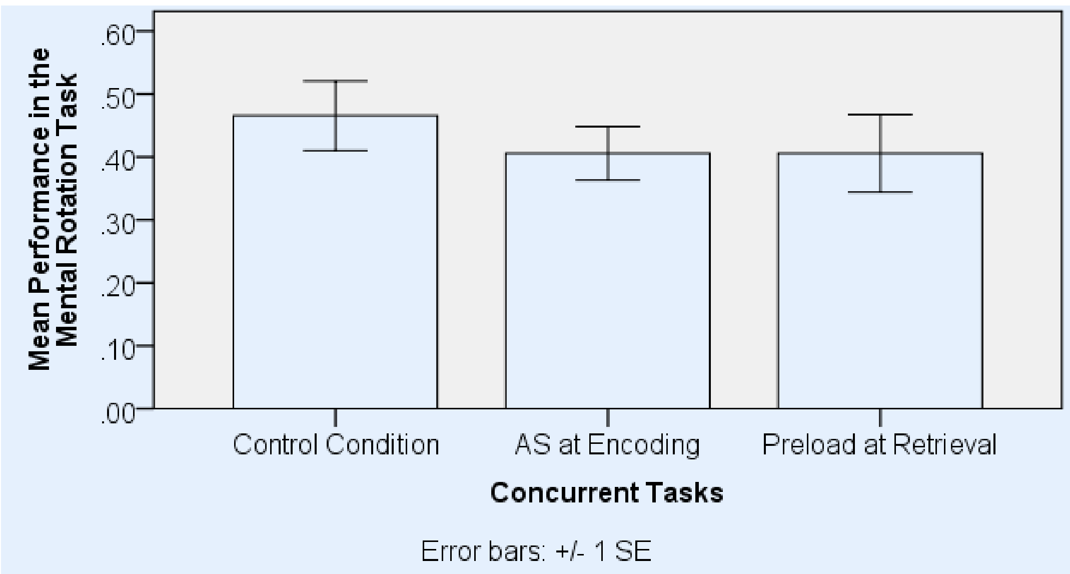


Figure 9. Performance in the rotation task in Experiment 3, expressed by the proportion correct score for items in each condition.

Performance in the digit recall task. In the digit recall task, used in the preload condition, participants were expected to recall the digits in their correct order, and they were given one score for each digit retrieved in the correct position. The mean number of digits correctly recalled per sequence was calculated in order to examine whether participants were able to do the task. As there were three digits in each sequence, the maximum score for each participant was 3. Performance on the digit recall was close to the ceiling level (M = 2.82, SD = 0.27).

Discussion

Experiment 3 aimed to examine the role of the verbal code at encoding and retrieval in a spatial context. It examined the effect of AS at encoding in the spatial presentation method. It also used the preload task at retrieval in a spatial context. The finding showed no impairing effect for AS at encoding or the preload task at retrieval compared to the control condition. This suggests that the verbal code is less useful in the spatial presentation method. This finding extends the finding of Experiment 1, in showing that the verbal code has little benefit when spatial information is emphasized.

Analysis across Experiment 2 and 3

The three conditions (control, AS at encoding, and preload at retrieval) of the spatial presentation experiment were compared with the equivalent three conditions in the computer-based temporal presentation experiment. To revisit the main differences between the two experiments; in the spatial presentation experiment, the shapes were distributed on the screen and shown to participants three times in a different order each time, while in the temporal presentation experiment, the shapes were presented in the middle of the screen and were shown to participants three times in the same order. In addition, at retrieval, participants in the spatial presentation experiment were shown six empty squares in the same locations they were presented at encoding. One of the squares was highlighted and participants recalled the shape that was previously presented in the same position as the highlighted square. Participants were always asked to recall the shapes in a different order from the order they were presented at encoding. In the temporal presentation experiment, participants were asked to recall the shapes in their order and no spatial cues were given as all the shapes were presented in the middle of the screen. Participants in both experiments were instructed to identify two embedded letters in each shape and were told that the two letters are English capital letters joined together. It was not mentioned that the two letters might only share one side or that they cannot be drawn inside each other. Therefore, a flexible criterion was used to mark the correct answers, as for some shapes there was more than one accepted answer (i.e., the letters can be joined together or drawn inside each other). The flexible criterion is suitable for the comparison as the stimuli taken from both experiments were both easy-to-name shapes.

Each of the six compared conditions has 15 participants from the same population; they were all adults between the age of 18 and 40, and were native English speakers.

Results

The scores for analyses by item were extracted using the same method of the previous experiments. See Figure 10 for the proportion correct score for items in each of the six conditions. Analyses by-participants showed a similar pattern of results and therefore are reported in Appendix E. However, it will be highlighted when there is a difference between item-based analyses and participant-based analyses. The *F* values for participant-based analyses, when presented in the chapter, will be named F^2.

A 2 (temporal vs. spatial) x 3 (concurrent tasks: control, AS at encoding, and preload at retrieval) ANOVA repeated measure design showed a significant main effect of the concurrent tasks, F (2, 10) = 7.21, $p < .01$, MSe = .01, η^2p= .59 (this effect was marginally significant by-participants; F^2 (2, 84) = 3.04, p = .053, MSe = .07, η^2p= .07). When collapsing across temporal and spatial presentation, performance in the control conditions (*M*= *.51*, *SD* = .16) was higher than performance on both AS at encoding condition (*M* = .35, *SD* = .8) and preload at retrieval (*M* = .4, *SD* = .13). No significant main effect was found for the method of presentation, F (1, 5) = .13, p = ns, MSe = .02, η^2p= .03. A significant interaction was found between the concurrent tasks and the method of presentation, F (2, 10) = 11.95, $p < .01$, MSe = .003, η^2p= .71 (though analyses by-participants showed no significant interaction between the concurrent tasks and the method of presentation, F^2 (2, 84) = 1.28, p = ns, MSe = .07, η^2p= .03).

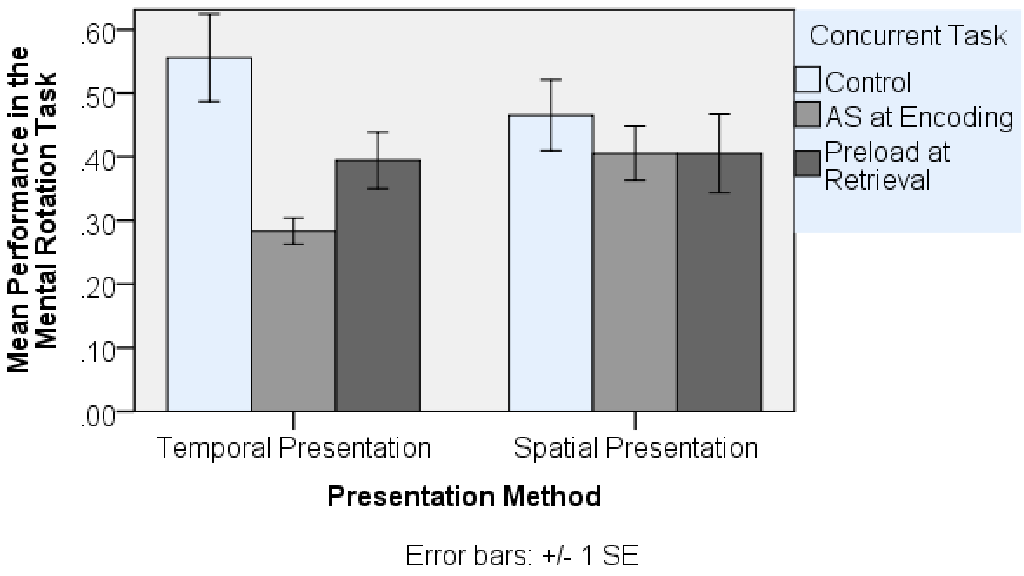


Figure 10. Performance in the rotation task across Experiments 2 and 3, expressed by the proportion correct score for items in each condition.

The interaction was explored by running separate analyses for AS at encoding and the preload task at retrieval. A 2 (temporal vs. spatial) x 2 (concurrent tasks: control vs. AS at encoding) ANOVA repeated measure showed a significant main effect of AS at encoding, F (1, 5) = 10.62, $p < .05$, MSe = .02, η^2p= .68. When collapsing across temporal and spatial presentation, performance in the control conditions (M= .5, SD = .15) was significantly higher than performance on AS at encoding condition (M = .34, SD = .08). No significant main effect was found for the method of presentation, F (1, 5) = .24, p = ns, MSe = .006, η^2p= .01. A significant interaction was found between the AS at encoding and the method of presentation, F (1, 5) = 30.14, $p < .01$, MSe = .002, η^2p= .86 (however, this effect was not significant by-participants, F (1, 56) = 2.46, p = ns, MSe = .07, η^2p= .04. The interaction was explored by dependent t tests. A dependent t test between the control condition (M = .51, SD = .14) and AS at encoding (M = .25, SD = .06) in the temporal presentation method showed significantly higher performance for the control compared to AS at encoding condition, t (5) = 4.94, $P < .01$. In contrast, a dependent t test showed no differences between the control condition (M = .47, SD = .14) and AS at encoding (M = .41, SD = .1) in the spatial presentation method, t (5) = 1.43, p = ns.

A 2 (temporal vs. spatial) x 2 (concurrent tasks: control vs. preload at retrieval) ANOVA repeated measure showed a marginally significant main effect of the preload task, F (1, 5) = 4.64, p = .084, MSe = .016, η^2p= .48. When collapsing across temporal and spatial presentation, performance in the control conditions (M= .5, SD = .15) was numerically higher than performance on preload at retrieval condition (M = .4, SD = .13). No significant main effect was found for the method of presentation, F (1, 5) = .92, p = ns, MSe = .01, η^2p= .16. No significant interaction was found between the preload task at retrieval and the method of presentation, F (1, 5) =.608, p = ns, MSe = .06, η^2p= .011. The pattern of the means suggests a larger difference between the control condition (M = .51) and preload condition (M = .36) for the temporal presentation condition than the difference between the control condition (M = .47) and preload condition (M = .41) in the spatial presentation condition. This pattern was significant in the analysis of Experiment 2 when including both easy-to-name and hard-to-name shapes. However, when only considering the easy-to-name shapes, the power of the analysis was reduced and, therefore, did not show a significant difference.

Discussion

Analyses across Experiments 2 and 3, focusing upon easy-to-name shapes, aimed to examine the effect of presentation method in moderating the role of the verbal code at encoding. In addition, it aimed to examine whether the presentation method moderates the role of the verbal code at retrieval. It compared the effect of the control, AS at encoding and preload at retrieval in both the spatial presentation method and the temporal presentation method. The results showed an interaction between the effects of the concurrent tasks and the presentation method. This finding largely confirms the pattern of results arising from the separate analyses conducted upon Experiments 2 and 3. The effects of AS at encoding appear more robust. AS at encoding impaired performance in the temporal presentation conditions, but showed no significant effects in the spatial presentation conditions. The preload task, however, showed a similar pattern of results in the temporal and spatial presentation conditions. As the across experiment analysis only included easy-to-name shapes, it is likely that this had reduced the power of the analysis and ability to observe significant effects. This finding extends the finding of Experiment 1, in showing that the verbal code is less reliable during both encoding and retrieval when temporal information is de-emphasised and spatial information is emphasized.

Summary

Chapter 2 and 3 included 3 experiments that examined the role of spontaneous covert naming in the mental rotation paradigm. Experiment 1 indicated that spontaneous covert naming at encoding is useful for easy-to-name shapes under temporal presentation conditions, but less useful under spatial presentation conditions. This was shown by the use of AS at encoding, whereby AS impaired performance compared to the control ‘no AS’ condition in the temporal presentation method, but AS at encoding did not show impairment in the spatial-temporal presentation condition. The positive role of spontaneous covert naming was explained by either the strengthening of encoding accounts (Daniel & Toglia, 1976; Ellis, 1968; Santa, 1975) or by the conjoint use of verbal and visual information at encoding and at retrieval (Bahrick & Bahrick, 1971). These accounts were examined in Experiment 2.

Experiment 2 replicated the findings for the positive role of spontaneous covert naming for easy-to-name shapes in the temporal presentation method (Experiment 1), and it extended the useful role for the verbal code to hard-to-name shapes. Additionally, it examined how AS and the preload task at retrieval affect performance in the temporal presentation method. Both AS and the preload task at retrieval impaired performance on easy-to-name and hard-to-name shapes. This implies that the role of the verbal code is useful at encoding and at retrieval of both easy- and hard-to-name shapes in the temporal presentation method. Hence, the positive role of spontaneous covert naming is likely to be due to the conjoint encoding of verbal and visual information so that verbal information can enhance retrieval of the visual information. Spontaneous naming is most likely to be used to encode information about order of the shapes at encoding so that the verbal information can facilitate recall of the shapes in their order at retrieval. This is suggested because AS and the preload task impaired performance in both easy-to-name and hard-to-name shapes. Showing similar impairment effects on easy-to-name and hard-to-name shapes suggests that spontaneous covert naming was not used to encode aspects related to the nature of the shapes (e.g., semantic information), but was rather used to encode other aspects, such as the order of the shapes.

Experiment 3 then aimed to place greater emphasis on spatial information and to examine the effect of concurrent tasks at both encoding and retrieval in the spatial presentation method. It found that the concurrent tasks did not show a significant effect on performance. This supports the findings from Experiment 1 that verbal information is less useful when spatial information is emphasized.

Finally, subsequent analyses across Experiments 2 and 3 included three conditions (control, AS at encoding, and preload at retrieval) from performance on easy-to-name shapes in the temporal presentation method (Experiment 2) and all three conditions, of the spatial presentation method (Experiment 3). The results showed an interaction between the effects of the concurrent tasks and the presentation method: AS at encoding and preload at retrieval were found to impair performance in the temporal presentation method, but no significant effect was shown in the spatial presentation method.

The overall findings from Experiment 1, 2 and 3 imply that the use of the temporal presentation method emphasises the use of the verbal code, and that once the verbal code is emphasized at encoding it becomes useful at retrieval (Bahrick & Bahrick, 1971). The positive role of the verbal code may be involved in encoding and retrieving the sequential order of the shapes (Pelizzon et al., 2002). The positive role of the verbal code here, however, is related to the use of spontaneous naming, and as has been mentioned, in Chapter 1, the effect of spontaneous naming is expected to be different from the effect of explicit labelling. Therefore, the next chapter will move from manipulating spontaneous naming to manipulating explicit labelling.

Chapter 4: The Role of Explicit Labelling in Visual Memory: Self-generated Labels

Experiment 4

Introduction

The key findings from the previous chapters indicate that covert spontaneous naming, when temporal information is emphasized, benefits performance in the mental rotation task. These findings using the temporal presentation method were clearly different from those observed using spatial-temporal presentations in previous research where spontaneous naming was found to impair performance (e.g., Brandimonte et al., 1992a; Brandimonte et al., 1992b; Pelizzon et al., 1999). It should be noted that in this current thesis, Experiment 1, using spatial-temporal presentation methods, and Experiment 3 using spatial presentation methods, did not replicate these detrimental effects of spontaneous naming. Indeed, no significant positive or negative effects of preventing spontaneous naming through AS were observed. However, taking these results together it seems clear that when spatial information is emphasised over temporal information use of the verbal code shows little benefit and may in fact impair performance on image manipulation tasks. Naming, so far in this thesis, has been manipulated implicitly by the use of AS vs. no AS at encoding or the use of either AS or preload task vs. no concurrent task at retrieval. However, such implicit spontaneous naming does not allow control of the relationship between the content of the verbalisation and the shape. It is important to examine this relationship because the circumstances under which naming helps might be due to the relationship between the content of verbalisation and the shape. Explicit labelling can control this relationship. Therefore, Experiment 4 marked a turning point in this research by manipulating explicit labelling.

Most of the studies that have used the mental rotation paradigm used a spatial-temporal presentation method (e. g., Brandimonte et al., 1992a; Brandimonte et al., 1997; Pelizzon et al., 2002; Brandimonte & Collina, 2008). Findings from these studies have implied that similar effects arise from explicit labelling and covert spontaneous naming. Brandimonte et al. (1992b) have shown that experimenter-generated labels, presented alongside hard-to-name shapes during encoding, can impair imagery performance. They have assumed that the effects are equivalent to those observed using spontaneous covert naming when presenting easy-to-name shapes. Consistent with this, labels presented during the learning of easy-to-name shapes did not impair performance relative to conditions where no labels were provided. That was because easy-to-name shapes were assumed to be spontaneously named by participants (Oldfield & Wingfield, 1965), as the name and the shape are already associated in memory (Mazard et al., 2005). Hence, for easy-to-name shapes experimenter-generated labels did not induce a further impairing effect. In contrast, hard-to-name shapes were not assumed to be spontaneously named by the participants (Mazard et al., 2005). Thus, performance on hard-to-name shapes was more accurate when no labels were used (and when presumably no spontaneous naming occurred) compared to when the shapes were explicitly labelled. Neuroimaging studies have shown that easy-to-name and hard-to-name shapes activate different cortical regions in the brain. For example, Kelley et al. (1998) showed that drawings resembling objects, which are assumed to be easy-to-name, activate the left inferior frontal and the left inferior temporal gyrus (which correspond to semantic and verbal information) while drawings that do not resemble objects do not activate these regions. This suggests that easy-to-name shapes and hard-to-name shapes may be represented differently in memory. This may account for their being differentially affected by explicit labelling when using the spatial-temporal presentation (e. g., Brandimonte et al., 1992a).

However, the findings from Experiment 2 in this research provided evidence that under encoding and retrieval conditions emphasising the use of temporal information, spontaneous covert naming occurs for both easy-to-name and hard-to-name shapes and is useful for the image rotation task. Thus, in that experiment, spontaneous naming appeared to similarly affect easy-to-name and hard-to-name shapes. However, easy-to-name shapes had better imagery performance, overall, than hard-to-name shapes. This might be because easy-to-name shapes are more readily matched with their names (Mazard et al., 2005; Mitchell & Brown, 1988). The match between the names and the shapes may imply that participants can more successfully use the verbal code to cue their memory during retrieval (Bahrick & Bahrick, 1971; Weldon, Roediger & Challis, 1989). Alternatively, easy-to-name shapes might be more deeply processed perhaps because they have more semantic information relative to hard-to-name shapes (Carr, McKauley, Sperber & Parmelee, 1982). Deeper semantic processing shows higher levels of memory performance (Craik & Lockhart, 1972; Daniel & Toglia, 1976; Ellis, 1968; Lewandowsky & Hockley, 1987; Lockhart & Craik, 1990; Bower & Karlin, 1974; Klatzky, Martin & Kane, 1982; Schmitt, Munte & Kutas, 2000). Additionally, naming might help to improve the quality or quantity of elements of the visual representations (Brown, Gehrke & Lloyd-Jones, 2010; Kerr & Winograd, 1982; Intraub & Nicklos, 1985; Santa, 1975; Wells & Hryciw, 1984; Winograd, 1981). Therefore, it is important to assess the quality of verbal labels assigned to easy-to-name and hard-to-name shapes, by examining the explicit labels that participants self-generate. This will be a useful tool to allow the assessment of label quality, and will inform whether the quality of verbal labels generated by participants is more highly matched with easy-to-name shapes compared to hard-to-name shapes.

It may be expected that explicitly labelling the stimuli may improve performance. This might be predicted on the basis of findings from previous visual imagery paradigms that have used the spatial-temporal presentation method (e. g., Brandimonte et al., 1992a). Brandimonte et al. assumed that explicit labelling of hard-to-name shapes was similar to the spontaneous covert naming of easy-to-name shapes as the presence of each type of naming during encoding was found to impair subsequent performance in the mental rotation task. On this basis, it may be expected that such similarities between spontaneous naming and explicit labelling would carry over to the temporal presentation method. Experiments 1 and 2 in this thesis indicated that covert spontaneous naming helps imagery performance using the temporal presentation method. Thus, it might be expected that verbalisation under temporal presentation conditions whether covert spontaneous naming or explicit labelling may benefit the encoding of temporal order information. This is because verbalization may enhance encoding the order of the shapes (Pelizzon et al., 2002) or remembering the items and their order (Paivio et al., 1975). Verbalization may, also, strengthen the encoding of the shapes (Ellis, 1968; Daniel & Toglia, 1976; Santa, 1975) by emphasizing the processing of semantic information (Ellis, 1968; Daniel & Toglia, 1976), or by integrating the features of the shapes into a single visual representation (Santa, 1975). Alternatively, verbalization may be helpful in linking verbal and visual information during encoding, and hence, the verbal information can be used to cue visual information at retrieval (Bahrick & Bahrick, 1971). In addition, a self-generated description during encoding of each item in a series has been shown to have positive effects compared to non-described items on visual recognition memory (e. g., Brown & Lloyd-Jones, 2005; Musen, 1991; Nakabayashi et al., 2011). In the current experiment self-generated labels would be provided for each shape, and therefore, self-generated labels might help memory performance in the imagery task, and perhaps especially when that label matches the whole shape, as in the case of easy to name stimuli. This might be expected if the relationship between the shape and the label is important.

Alternatively, self-generated labels might impair visual memory by shifting the emphasis between different types of visual representations. The shift of emphasis account was developed from findings in two different domains. The first account was for findings in the imagery domain. It was suggested that verbalisation shifts the representation of the shape from a featural representation that suits the imagery task to a global representation that has lost its details and does not suit the imagery task (Brandimonte & Collina, 2008). Brandimonte and Collina (2008) showed that memory for hard-to-name shapes was impaired by explicit self-generated labelling that took place after learning the shapes. The impairing effect of labelling was removed by cueing the memory with self-generated labels that corresponded to specific parts of the shapes. This suggests that labels that correspond to specific features of the shapes can retrieve the original featural representation of the shape which is useful for the imagery task. In contrast, cueing the shape with other experimenter-given labels that corresponded to global aspects of the shape did not help performance. These findings are consistent with the idea that shifting emphasis from a featural representation to a global representation impairs performance. However, these findings were observed using the spatial-temporal presentation method, where spontaneous naming was assumed not to occur for hard-to-name shapes. Therefore, the role of explicit labelling should also be tested in the temporal presentation method, where a positive effect of spontaneous naming for hard-to-name shapes has been clearly demonstrated. The second account is drawn from the visual recognition domain, which has also indicated that self-generating a label to a picture might have a negative effect (e. g., Grill-Spector & Kanwisher, 2005; & Lupyan, 2008), and that the effect might be differential depending on the match between the shapes and the labels. For example, Lupyan (2008) studied the effect of verbal categorization on visual recognition. Lupyan showed participants a sequence of pictures that were either easy-to-name (e. g., a picture of chair) or ambiguous and hard-to-name, (e. g., an ambiguous picture that might be seen as a chair or a table) and asked them to label the pictures or not (i.e., the control condition), and then tested their memory of the pictures in an old/new recognition test. The results showed that overt categorical labelling impaired subsequent recognition of the easy-to-name pictures. In contrast, when the shapes were ambiguous, overt categorical labelling did not impair visual recognition of the pictures. Lupyan suggested that overt categorical labelling of easy-to-name pictures created prototypical representations of the pictures, and this compromised the unique identity of the pictures. The idea of the prototypical transformation implies that items are changed in memory by a top-down modulation from a pre-existing prototypical image. The size of the top-down modulation depends on how relevant the acquired item is to the prototypical item (Bransford & Franks, 1971; Franks & Bransford, 1971). This can be applied to the labelling effect on pictures. Unambiguous pictures possess stronger links with their labels, compared to ambiguous pictures. Thus, verbal labels are strongly activated by a bottom-up signal from processing of unambiguous pictures, and this in turn produces top-down feedback from the verbal label to the representation. Therefore, a larger representation shift is found when labelling unambiguous than when labelling ambiguous pictures. Hence, it was expected that explicit labelling would have different effects on easy-to-name and hard-to-name shapes. In Experiment 4, the effects of self-generated explicit labelling were compared with the effects of covert spontaneous naming in a control condition, where no labels were used. Hard-to-name shapes can be considered ambiguous pictures. They have a weaker link to their labels (Mazard et al., 2005), and hence, access to a prototypical representation is weaker. Therefore, they may be less likely to be influenced by self-generated labelling. In contrast, easy-to-name shapes have a stronger link to their labels (Mazard et al., 2005), and hence, access to a prototypical representation is stronger. Therefore, self-generated labelling might induce stronger impairment of easy-to-name shapes compared to hard-to-name shapes. This account appears to be similar to the representation shift account by Brandimonte and Collina (2008). They have the similar suggestion that labelling pictures can produce a representation that does not visually match the original stimulus. However, the representation shift account by Brandimonte and Collina has not yet considered the differences that might arise when explicitly labeling easy-to-name and hard-to-name shapes. Given that in a temporal presentation method covert spontaneous naming has been found to benefit subsequent memory performance, accounts that predict a negative effect of self-generated explicit labelling on imagery performance raise an interesting possibility: That is that different effects of spontaneous naming and explicit labelling on imagery performance will be observed.

Experiment 4 therefore used the mental rotation task with easy-to-name and hard-to-name shapes, in a temporal context. Self-generated labels were manipulated through the explicit instruction to generate labels during encoding, and two contrasting sets of predictions were made. First, explicit self-generated labelling was expected to help memory. This is based on the finding of a positive role for spontaneous naming in the temporal context (Experiments 1 and 2), and the assumption (drawn from studies using spatial-temporal presentation) that covert spontaneous naming and explicit labelling during encoding have a similar effect in visual imagery paradigms (Brandimonte et al, 1992a). However, self-generated labelling was expected to show higher performance compared to spontaneous naming. This is based on the findings from a picture recognition study by Nakabayashi et al. (2011), where pictures of objects were presented and verbalization was provided after each item in the series. Performance in explicit verbalization (i.e., writing a brief description of the item) was higher than performance in spontaneous verbalization (a no AS condition), which in turn was higher than performance when verbalization was prevented through AS. In contrast, self-generated labels might show a negative effect compared to spontaneous naming, based on studies using visual recognition (e. g., Lupyan, 2008) and visual imagery (Brandimonte & Collina, 2008, using spatial-temporal presentation). Finally, regardless of whether positive or negative effects of explicit labelling occur, the relationship between the shapes and the labels is likely to be important. Therefore, easy-to-name shapes compared to hard-to-name shapes were expected to be more strongly affected by self-generated labels (either positively or negatively), as easy-to-name shapes are more readily matched with their names (Mazard et al., 2005).

Participants

Eighty healthy adults (59 females, 21 males), age range 18-34 (mean = 21 years and 8 months) were recruited from the University of Leeds. All participants had normal or correct-to-normal vision, were native English speakers, and had not participated in any of the previous mental rotation experiments. Each participant was randomly allocated to one of four conditions; each condition had 20 participants. All participants gave their informed consent prior to the experiment, and were paid a small amount of money in return for their participation.

Materials

The stimuli included shapes, which are taken from the study by Brandimonte and colleagues (1992a) and were previously used in this thesis. These were six easy-to-name shapes, used in Experiments 1, 2 and 3, six hard-to-name shapes, used in Experiment 2, and two additional shapes generated by the researcher for the purposes of including a practice trial. The shapes were presented as black drawings in white squares (12 x 12 cm) on a grey screen ([1]). Each shape reveals two capital English letters when rotated a vertical angle anti-clockwise. As mentioned earlier, Brandimonte and colleagues used a nameability agreement test to categorize the shapes. Shapes which received 50% agreement on their names were classified as easy-to-name shapes.

([1]) In Experiment 4, unlike the previous experiments in this research, the shapes were drawn inside white squares presented on a grey screen. One might argue that participants named the border instead of naming the shapes. Brandimonte et al. (1997) found that easy-to-name shapes are better remembered when they are drawn on easy-to-name cards (e. g., a square card) compared to when drawn on hard-to-name cards. They concluded that people tend to name the shapes of the easy-to-name cards instead of naming the shapes themselves. However, in the current experiment, participants were debriefed after the experiment about their memory strategies and reported naming the shapes rather than naming other external contexts. Additionally, all the six shapes were presented in white squares on the same grey background whereas in the previous research, showing this effect, shapes were each presented on a variety of unique backgrounds. Therefore, it is unlikely that participants consistently named the white border and did not name the six shapes. Moreover, this assumption of naming the background is further ruled out in Experiment 5 in this thesis, where similar results, as here, were obtained when the shapes were not presented within a border. See page 124 in Chapter 5.

Design and Procedures

The design was a 2 (shape type: easy-to-name vs. hard-to-name) x 2 (label type: control vs. self-generated labels) between-subjects factorial design. The dependent variable was the number of letters correctly identified in each condition.

Participants were tested individually in a session lasting about 10 minutes. The procedures for the mental rotation task followed the procedures outlined in Experiment 2. The six shapes were presented one after the other on a computer screen three times in total. Participants were asked to memorize the shapes. Participants in the labelling conditions were given further instructions that they should label the shapes out loud while they memorized them, and their labels were recorded by the experimenter. The instructions were taken from the previous experiments in this research and were modelled after those used by Brandimonte et al. (1992a), but additional instructions for labelling were added as follows: 'You are going to view six shapes, shown at a rate of five seconds each. The presentation will be shown three times. Your task is to memorize the shapes. You are, also, asked to name the shapes out loud. Please, be consistent on your names, and do not change a name of any shape across the three presentations.' Participants, in the control condition, were debriefed as to whether they named the shapes during their initial presentation, and all participants in the easy-to-name condition reported that they named the shapes to memorize them. Participants in hard-to-name conditions used mixtures of strategies to memorize the shapes (e. g., naming and dividing shapes).

Immediately after learning the shapes, participants were informed about the image manipulation task and were allowed to practice it and then participants undertook the image manipulation test. Participants were asked to recall the shapes one after the other in their order. There was a five-second waiting screen before participants recalled each shape and a tone after this screen indicated that they could start generating an image of the shape in their heads to perform the image manipulation task. The response screen appeared after the tone and asked participants to identify the two letters making up each shape and to press the two appropriate letters on the keyboard.

Results

Performance in the mental rotation task. For each participant, a proportionally corrected score for each item was calculated by dividing the number of correct letters in each response by the number of possible correct answers. As there were two correct answers for each shape, participants' responses were scored as 0, .5, or 1 when they gave 0, 1, or 2 correct letters, respectively. Within each condition participants responses were then pooled to provide a mean proportion correct score for each item. See Figure 11 for the mean proportion correct scores for each condition. Analyses by-participants provide a similar pattern of results, and therefore, are reported in Appendix F. However, it will be highlighted when differences between the by-items and by-participants analyses arise. The *F* values for by-participant analyses, when presented in the chapter, will be labelled as F^2.

A 2 (shape type: easy-to-name shapes vs. hard-to-name shapes) x 2 (label type: self-generated labels vs. control) mixed ANOVA, having shape type as a between group factor and labelling as a within subject factor, revealed that there was a significant main effect of label type on participants performance in the rotation task, F (1, 10) =24.79, $p < .001$, $MSe = .003$, $\eta^2_p = .71$. Performance in the control condition ($M = .35$, $SD = .07$) was higher than performance in the self-generated label condition ($M = .25$, $SD = .06$). The main effect of shape type was not significant F (1, 10) = 1.641, p = ns. There was no significant difference between performance on easy-to-name shapes (*M* = .28, *SD* = .04) and performance on hard-to-name shapes (*M* = .32, *SD* = .08). The effects of the self-generated labels did not interact with the shape type, F (1, 10) = 2.34, p = ns.

Previous researchers (e. g., Brandimonte et al., 1992a) had shown that explicit labelling affected easy-to-name shapes and hard-to-name shapes differently. To explore further the influence of label type on performance, the effect of self-generated labels on easy-to-name shapes and hard-to-name shapes was considered, separately. A one way ANOVA between easy-to-name control (*M* = .35, *SD* = .05) and easy-to-name self-generated labels (*M* = .21, *SD* = .03) revealed lower performance for self-generated labels compared to the control condition, F (1, 5) = 24.03, $p < .01$, *MSe* = .002, $\eta^2_p = 83$. In addition, a one way ANOVA between hard-to-name control (*M* = .36, *SD* = .09) and hard-to-name self-generated label condition (*M* = .28, *SD* = .07) revealed a marginally significant effect of self-generated labels, F (1, 5) = 5.32, p = .069, *MSe* = .003, η^2_p = 52 (however, this comparison was not significant in the analysis by-participants , F^2 (1, 38) =, 87, p = ns). In addition, a Cohen's *d* was calculated for the effect size of self-generated labelling compared to the control condition for each set of shapes, using the sample size of each group, the *df* within each group and *F* value. Self-generated labelling had a larger effect size (Cohen's *d* = 4.38) for easy-to-name shapes compared to that found on hard-to-name shapes (Cohen's *d* = 2.06).

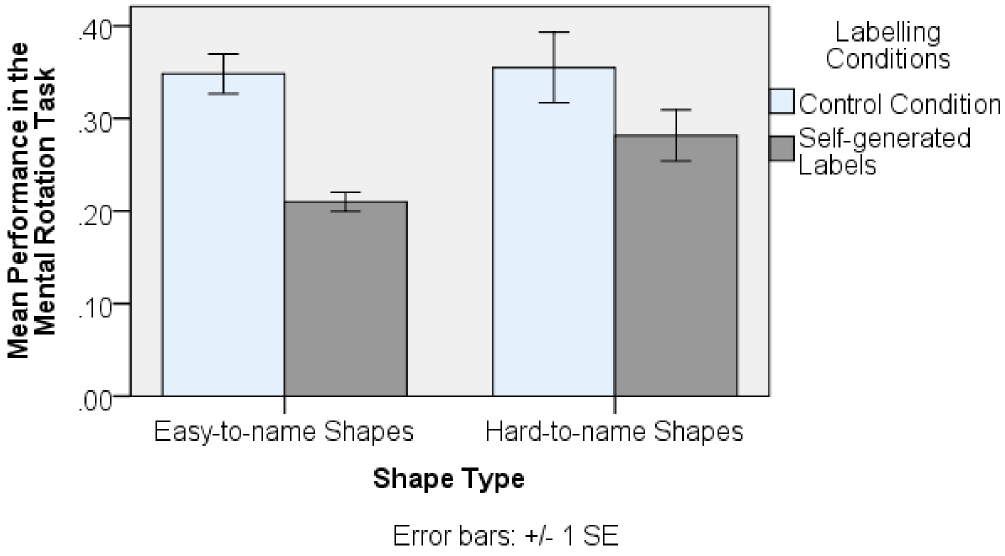


Figure 11. Performance in the rotation task in Experiment 4, expressed by the proportion correct score for items in each condition.

Quality of verbal labels. The quality of verbal labels given by participants to the shapes was judged by two independent judges, based on how well the verbal labels matched the whole shapes on a four point scale (1: poor to 4: good). The shapes and the labels were printed on A4 paper, where each shape was presented on a single page. The labels were listed with the 4 point scale below each shape. The instruction given to judges was as follows: 'There are 12 figures; each figure has been given different names. We want to find how well the names match the figures. Your task is to evaluate whether the names are appropriate for the whole figure. You are asked to rate the goodness of the names on a 4-point scale, where 4 means the name matches the whole figure very well, and 1 means the name does not match the figure at all'. The correlations between the ratings of the two judges were significant overall, r = .66, $p < .001$, for easy-to-name shapes, r = .656, $p < .001$, and for hard-to-name shapes, r = .631, $p < .001$.

The score given to each label was the mean of the two judges' scores for that label (see Appendix G for the names given by participants and the mean scores given by judges). Then participants were given a mean score for their label accuracy across the six shapes. An independent sample *t* test between participants' scores of labelling quality in the easy-to-name group (M = 3.05, SD = 0.57) and participants' scores of labelling quality in the hard-to-name group (M = 2.2, SD = 0.44) showed a significant advantage for easy-to-name shapes, t (38) = 4.44, $p < .0001$.

Discussion

Experiment 4 moved from manipulating spontaneous naming to explicit labelling using temporal-based presentation in the mental rotation paradigm. It set out to examine the effect of explicit labelling, using self-generated labels during learning of easy-to-name and hard-to-name shapes. One possibility was that explicit labeling might show positive effects compared to spontaneous naming (Nakabayashi et al., 2011). Alternatively, explicit labeling might impair performance compared to spontaneous naming (Grill-Spector & Kanwisher, 2005; Lupyan, 2008). It was also aimed to examine whether explicit naming has differential effects on easy-to-name and hard-to-name shapes.

The results showed that using self-generated labels had a different effect from the control condition. Self-generated labels impaired imagery performance compared to spontaneous naming. Moreover, there was a trend towards the negative effects of self-generated labels being more apparent for easy-to-name than hard-to-name shapes. However, the overall difference between the two types of shapes was not significant. The lack of significant differences between easy-to-name shapes and hard-to-name shapes will be further discussed below. Additionally, analyses of the quality of verbal labels indicated that global labels given to easy-to-name shapes were rated as a better match to the shapes than labels given to hard-to-name shapes.

It will be discussed below why easy-to-name shapes which are more matched with their labels were largely affected by self-generated labels.

The results showed a significant negative effect of self-generated labels, compared to spontaneous naming. There was no interaction between the presence or absence of self-generated labels and shape type. Nevertheless, analyzing performance for easy-to-name and hard-to-name shapes separately showed significantly lower performance for self-generated labels compared to the spontaneous naming condition for easy-to-name shapes whilst a similar pattern was only marginally significant for hard-to-name shapes. In addition, the effect size for self-generated labeling was greater on easy-to-name compared to that on hard-to-name shapes. This suggests that the impairing effect of self-generated labeling is more apparent for easy-to-name shapes. The negative effect of such explicit labelling on visual memory is consistent with findings in picture recognition (e. g., Grill-Spector & Kanwisher, 2005; & Lupyan, 2008), which indicated that explicit labeling had a different effect from spontaneous naming. Other previous studies in picture recognition have shown a positive effect for self-generated verbalization on picture recognition (e. g., Musen, 1991; & Nakabayashi et al., 2011). However, these studies have used self-generated descriptions rather than self-generated labels. The effect of verbalization might differ according to these differences in task demands.

How might these findings be explained? Self-generated labels might have shifted the original visual representation. For example, labeling may have created a global representation of the shapes that lost the detailed features (cf. Brandimonte & Collina, 2008) or encouraged the use of a prototypical representation rather than the original representation of the shape (cf. Lupyan, 2008). Access to accurate detailed features is important in order to perform the image manipulation task (Brandimonte & Collina, 2008). Therefore, providing self-generated labels impaired imagery performance.

The quality of verbal labels given to easy-to-name shapes was significantly higher than labels given to hard-to-name shapes. See Appendix G for the names given by participants to the shapes and the rating of judges. These results suggest that easy-to-name shapes are better matched to their labels, suggesting that they call upon more prototypical category labels. There is evidence that easy-to-name shapes are more affected by their category labels (Lupyan, 2008). According to this account, it was expected that easy-to-name shapes which are largely matched with their labels (Mazard et al., 2005) would show larger effects of self-generated explicit labelling than hard-to-name shapes. There was a trend, although not significant, for larger impairing effects of the labelling manipulation for easy-to-name shapes than hard-to-name shapes. Hence, the following experiments focus on examining the association between easy-to-name shapes and their labels to further explore whether the degree of match between the labels and shapes is an important determinant of the interfering effects of explicit labelling indicated in Experiment 4.

One might argue that self-generation of labels causes a shift from spontaneous naming to a more effortful verbal labeling, which is responsible for a general detriment in encoding. Preliminary evidence for the differential effort used to spontaneously name and explicitly label pictures comes from priming studies showing that pictures give quick access to their semantic information but slower access to their explicit labels (e. g., Carr et al., 1982; Mitchell & Brown, 1988). This suggests that explicit self-generated labelling may be more effortful compared to spontaneous covert naming. There is evidence from the literature that suggests that effortful processes interfere with spontaneous processes (Erikson, Webb & Fournier, 1990; Kimble & Perlmuter, 1970; Hasher & Zacks, 1979; Parkin & Russo, 1990). Therefore, this shift in processing from spontaneous to intentional effortful verbalization might interfere with the visual encoding of the shapes. However, this general detriment in encoding might predict larger impairment on hard-to-name shapes, if it is assumed it takes greater effort to generate these names, compared to easy-to-name shapes. However, the findings showed the opposite trend.

Another finding was that the overall difference in performance between easy-to-name shapes and hard-to-name shapes was not significant. It was expected to find a significant difference between the two types of shapes based on findings from Experiment 1 and 2. However, viewing the literature, there have been occasions where visual imagery experiments have failed to detect a difference between easy-to-name shapes and hard-to-name shapes (e.g. Brandimonte et al., 1992a, Experiments 1 & 2). In fact, the absence of a significant difference in Experiment 4 reflects the inconsistent effects of nameability that are apparent in the wider literature.

Conclusion

In summary, Experiment 4 used a computer-based version of the temporal mental rotation paradigm, previously established in this research, and manipulated self-generated labelling on easy-to-name and hard-to-name shapes. It was aimed to examine whether self-generated labels have similar effects to covert spontaneous naming. The results showed that self-generated labels impaired performance, and this effect was different from the positive effect of spontaneous naming (Experiments 1 and 2). The impairing effect of self-generated labels was somewhat more apparent on performance on easy-to-name shapes compared to hard-to-name shapes (caution is required when interpreting this finding as there was a lack of a significant interaction between the effects of shape type and explicit labelling). Additionally, the results showed a higher quality of verbal labels to be given by participants to easy-to-name shapes compared to hard-to-name shapes. Taken together, the results of this experiment serve to establish that self-generated labelling as an example of explicit labelling operates differently from covert spontaneous naming, at least for the temporal presentation method. These differences between spontaneous naming and explicit labeling have not previously been observed in previous spatial-temporal paradigms (Brandimonte et al., 1992a). The following experiments aimed to further explore the relationship between visual shapes and explicit verbal labels. Therefore, Experiment 5 focused on easy-to-name shapes, and manipulated explicit experimenter-generated labels in order to control the relationship between the shapes and the labels.

Chapter 5: The Role of Explicit Labelling in Visual Memory: Experimenter-generated Labels

Experiment 5

Introduction

The results, so far, suggest a differential effect for spontaneous naming and explicit labelling when a temporal presentation method is used, showing facilitation by the assumed spontaneous naming in the control conditions in comparison to conditions involving AS (Experiments 1 and 2) and interference by explicit self-generated labels (Experiment 4). These effects occurred on both easy-to-name and hard-to-name shapes. These findings differ from conclusions drawn by previous work where it has been inferred that spontaneous naming and explicit labelling exert similar impairing effects under the spatial-temporal presentation method in the mental rotation paradigm (e. g., Brandimonte et al., 1992a). Easy-to-name shapes, in particular, were highly influenced by explicit labelling in Experiment 4, and showed a stronger match with global labels. Experiment 5 therefore manipulated the nature of explicit experimenter-generated labels presented alongside easy-to-name shapes: common nouns (appropriate labels) and nonwords. Here the effects of appropriate labels, which are matched with the shapes, are compared with nonwords, which are not previously matched with the shapes. This comparison might help to examine whether the negative effect of explicit labelling in the temporal presentation method is influenced by the relationship between the shape and the verbal label.

Different predictions for the negative effect of explicit labelling on imagery performance may be made based on three different kinds of theoretical accounts. The first possible group of accounts are those proposing a shift in emphasis. The shift in emphasis explanation underlies two separate accounts developed to account for findings in different domains. The first is the representation shift from featural to global representation in visual imagery (Brandimonte & Collina, 2008). The second account is the shift from an actual to a prototypical image in visual recognition (Lupyan, 2008). However, the two accounts have the similar suggestion that labelling pictures can produce a visual representation that does not visually match the original stimulus. This implies that providing experimenter-generated labels alongside the shapes during presentation would impair performance compared to spontaneous naming.

The representation shift account from featural to global representations is consistent with work undertaken by Brandimonte and Collina (2008) however, they did not examine the differences between effects of labels that were strongly linked and less strongly linked to shapes during encoding. They also, did not look at easy-to-name shapes where it may be expected that a stronger link between the shape and the label is evident. However, Lupyan (2008) showed that the shift to the prototypical picture was larger when the shape was close to the prototypical picture associated with the label. Hence, it might be the case that verbal labels that are associated with prototypical images (e.g., common nouns) (Hamilton & Geraci, 2006; Vaidya & Gabrieli, 2000) can cause relatively more impairment than labels that are not associated with prototypical images (e.g., nonwords). Hence, it can be predicted, based on the shift in emphasis accounts, that providing appropriate labels during the presentation of the shapes at encoding would cause more impairment compared to providing nonwords.

In addition, Experiment 5 will also examine the effectiveness of retrieval cues, and different predictions can again be made based on the different theoretical accounts. The shift from an actual to a prototypical picture account by Lupyan (2008) did not examine the effect of retrieval cues. However, it was not expected, based on the representation shift from a featural to a global account by Brandimonte and Collina (2008), that re-presenting experimenter-generated labels as cues would improve performance compared to no cue conditions. Brandimonte and Collina (2008) showed that self-generating labels to hard-to-name shapes after learning impaired memory, and that experimenter-generated labels at retrieval did not benefit memory for hard-to-name shapes. In contrast, only self-generated common nouns (i.e., generated during encoding) and colour cues re-presented at retrieval can overcome these labelling effects and enhance performance. Brandimonte and Collina concluded that self-generated common noun cues and colour cues shifted the representation to the original featural representation, and therefore improved performance. Consistent with this, a positive correlation was found between the self-generated labels, when they corresponded to features of the shapes, and accuracy in performance in the mental rotation task. In contrast, cueing with a self-generated global/prototypical label did not help performance. The global label maintained the emphasis upon the global representation and therefore did not shift the participant back to the highly detailed visual representation that was originally encoded. However, Brandimonte and Collina used the spatial-temporal presentation method which has previously shown a similar pattern of effects for spontaneous naming and explicit labelling on imagery performance for easy-to-name shapes. In contrast, the current experiment aimed to use the temporal presentation method which showed a beneficial effect of covert spontaneous naming (Experiments 1 and 2), but an impairing effect of explicit self-generated labels on imagery performance (Experiment 4). Additionally, they used hard-to-name shapes, where the links between the labels and prototypical pictures are weak. Therefore, Experiment 5 will examine whether cueing easy-to-name shapes with experimenter-generated labels would remove the negative effects of labelling and improve performance in the temporal presentation method.

The second kind of account for the effect of explicit naming on memory is the pair association account. The pair association account may apply on the findings from Experiment 5, where experimenter-generated labels were used, as this account mostly focuses on the use of presenting labels alongside shapes during encoding. The pair association account is different from those accounts under the shift in emphasis group. This account is based on the linking of verbal and visual representations, rather than the shift from a more detailed to a less detailed visual representation. This account suggests that presenting labels alongside the shapes during the learning phase would impair performance compared to the control condition. This prediction arises because there is evidence that words are more susceptible to forgetting, compared to pictures (Nelson, Reed & Walling, 1976; Shepard, 1967; Ally & Budson, 2007) and that forgetting a member from a pair impairs memory for the whole pair (Hockley & Bancroft, 2011; Sakai & Miyashita, 1991). Additionally, presenting nonwords alongside the shapes might show larger impairment compared to appropriate names. Nonwords are more likely to be forgotten compared to common words (Greene, 2004; Xu & Malmberg, 2007). Thus memory for shapes associated with nonwords might be lower than memory for shapes associated with common words. Additionally, re-presenting the labels as cues was expected to improve performance. According to the pair association account presenting verbal labels alongside shapes at encoding would result in the creation of verbal-visual associations. Hence, presenting the verbal labels as cues at retrieval can trigger the shape that has been already associated with the label (Verhaeghen et al., 2006). This would be shown by a positive effect of cueing compared to no cueing conditions when collapsing across both appropriate labels and nonwords. However, appropriate cues might show larger improvement compared to nonwords as they create stronger associations with the shapes (Verhaeghen et al., 2006).

The third possible account for the findings is a detriment in encoding, where not enough information is encoded and cannot be retrieved from memory. An argument could be made that adding experimenter-generated labels to the shapes will detract from encoding information about the shape itself. The general detrimental effect may occur because there is more information to be processed in the labelling conditions compared to the control condition. Presenting labels alongside the shapes increases the number of items to be memorized, and increasing the number of items in a sequence increases the percentage of forgotten items (Postman & Phillips, 1965; Phillips, Schifrin & Atkinson, 1967; Shiffrin, 1970; Calfee & Atkinson, 1965; Laughery & Pinkus, 1966). The detriment in encoding is essentially similar to the divided attention account, where secondary tasks are added to reduce available processing resources for the primary items. In this case, central executive control resources become overloaded and encoding of the primary task items is disrupted (Kahneman, 1973; Troyer & Craik, 2000; Verhaeghen, Cerella & Basak, 2004). Divided attention was not expected to occur in Experiment 4, where participants provided self-generated names for the shapes, but it might occur in Experiment 5 as the labels were presented alongside the shapes. Based on the detriment in encoding account, it is expected that presenting experimenter-generated labels at encoding would impair performance compared to spontaneous naming, where no labels are presented with (easy-to-name) shapes. Any type of explicit label can impair performance regardless of whether it is largely matched with the shape. Furthermore, such an account suggests that insufficient information was originally encoded, but representing the verbal labels as cues at retrieval can, occasionally, be helpful for memory.

Experiment 5 aimed to compare experimenter-generated labelling conditions with a control condition, where no labels were provided and spontaneous naming was assumed to be used. Experimenter-generated labels during encoding were expected to impair performance according to the shift in emphasis account, the pair association account, and the detriment in encoding account. The experiment also aimed to compare the effect of two different types of experimenter-generated labels: appropriate labels and nonwords. According to the shift in emphasis account appropriate labels might cause more impairment compared to nonwords because appropriate labels are associated with prototypical pictures (Hamilton & Geraci, 2006; Vaidya & Gabrieli, 2000), and so are more likely to cause such a shift. In contrast, the pair association account suggests more impairment in the nonword condition compared to the appropriate label condition because nonwords are more likely to be forgotten compared to common words (Greene, 2004; Xu & Malmberg, 2007). The detriment in encoding account might suggest a similar impairing effect for appropriate labels and nonwords. Additionally, the experiment aimed to examine the effect of re-presenting the experimenter-generated labels as cues at retrieval. If the pair association account is applicable, then re-presenting the verbal labels as cues at retrieval would improve performance compared to the no cue conditions because re-presenting one item from the pair helps to retrieve the whole pair (Verhaeghen et al., 2006). In contrast, the shift in emphasis account does not expect improvement in performance by re-presenting the verbal labels as cues at retrieval because the global/prototypical labels do not shift the representation back to the detailed representation that is helpful for the imagery task. The detriment in encoding account does not have a clear prediction for the effect of cueing. It suggests that insufficient information were encoded, but cueing at retrieval can, occasionally, help performance.

Participants

One hundred healthy adults (79 females, 21 males), age range 18-33 (mean = 22 years and 2 months) were recruited from the University of Leeds. All participants had normal or correct-to-normal vision, were native English speakers, and had not participated in any of the previous experiments that used the mental rotation paradigm. All participants gave their informed consent prior to the experiment, and were paid a small amount of money in return for their participation.

Materials

The stimuli included the same six easy-to-name shapes used in Experiments 1, 2, 3 and 4. The shapes were presented as black drawings in the centre of a white screen, and no frames were drawn around the shapes so as to rule out the assumption that participants named the frames instead of naming the shapes.

The appropriate labels were the agreed names from Brandimonte's and colleagues naming agreement test (1992a). Table 4 shows the agreed name for each shape and the number of participants reported by Brandimonte et al (1992a) as having agreed on that name. It also shows the nonwords matched to each shape. Nonwords were generated by the researcher using nonwords generator software (http://www.maccs.mq.edu.au) (Rastle, Harrington & Coltheart, 2002). Each nonword had one syllable and had no neighbours (i.e., words that can be created from nonwords by changing only one letter). Nonwords' neighbours might affect recall of the nonwords (Roodenrys & Hinton, 2002; Thorn & Frankish, 2005). This is because lexical similarities between nonwords and their neighbours allow participants to access concrete or semantic information related to real words and this enhances their memory of nonwords (Thorn & Frankish, 2005). Therefore, it was important to generate nonwords that do not have neighbours. The nonwords were matched to the appropriate names in terms of number of letters and the same nonword always appeared with the same shape across all participants.

Table 4. Names of shapes and numbers of participants agreeing on the names and nonwords assigned to each shape in Experiment 5.

Shapes	*Correct Answers*	*Appropriate Names*	*Participants agreed on the name*	*Nonwords*
1	AB	Mask	15	Inse
2	TL	Chair	15	Pogms
3	EH	Music stand	8	Krurg
4	CH	Lamp	8	Dryk
5	EC	Bridge	8	Wherch
6	CD	Ball	12	Yoab

Design and Procedures

The design was a 2 (label type: appropriate labels vs. nonwords labels) x 2 (cue type: cues vs. no cues) between-subjects factorial design. In addition, a control group, which was not shown any verbal labels or cues, was also included.

Participants were randomly assigned to one of the five groups; each had 20 participants, (control group, assumed to allow spontaneous naming; appropriate verbal labels at encoding; nonwords labels at encoding; appropriate verbal labels at encoding and as cues at retrieval; nonwords labels at encoding and as cues at retrieval). Procedures were the same as that of Experiment 2. The six shapes were presented one after the other, at a rate of five seconds each, on a computer screen three times in total. The order of the six shapes was the same across the three rounds of presentation and was varied across participants. Immediately after learning the shapes, participants were informed about the image manipulation task and were allowed to practice it, and then undertook this test. Participants were asked to recall the shapes one after the other in their order. There was a five-second waiting screen before participants recalled each shape. A tone after this waiting screen indicated to participants that they could start generating an image of the shape in order to perform the image manipulation task.

Participants in the labelling conditions were shown either appropriate labels or nonwords in a black font one centimetre below the shapes. No further instruction was given to participants in the labelling conditions in respect of the labels ([1]). In the cueing conditions, participants were shown either the appropriate names or the nonwords they had previously viewed with the same shapes, as cues at retrieval. They were shown the verbal cue in a black font on the centre of the screen. This

---

([1]) One might argue that presenting labels during encoding impaired performance because participants were looking at the labels instead of looking at the shapes. However, previous studies have shown that focus of attention on the main items during encoding was not distracted and moved to the secondary items presented alongside the main items, unless participants were instructed to attend to the secondary items (Minamoto, Osaka, Engle & Osaka, 2012; Troyer & Craik, 2000). Therefore, the participants' attention was not directed by the experimenter to the labels and they were not asked to memorize the labels presented alongside the shapes. Thus, it is less likely that impairment in the labelling conditions was because participants were not looking at the shapes.

appeared after the tone used to indicate that participants could start the image manipulation task. Below the label a sentence asked participants to rotate the shape.

Results

Within each condition participants responses were pooled to provide a mean proportion correct score for each item. The researcher calculated a proportion correct score for each of the six items seen by each participant by dividing the number of correct letters in each response by the number of possible correct answers (i.e., out of a maximum of two per item). See Figure 12 for the mean proportion correct scores for each condition. Analyses by-participants provide a similar pattern of results, and therefore, are reported in Appendix H. However, it will be highlighted when differences between the by-participants and by-items analyses arise. The *F* values for participant analyses, when presented in the chapter, will be named F^2.

It was first aimed to examine the general effect of the type of the verbal label. This would show whether appropriate names, in general would show better imagery performance compared to performance influenced by nonwords. A 2 (label type: appropriate labels vs. nonwords) x 2 (cue type: cues vs. no cues) repeated measures analysis of variance (ANOVA) revealed a significant main effect of label type on participants performance in the rotation task, $F(1, 5) = 29.08$, $p < .01$, $MSe = .003$, $\eta^2 p = .85$. Performance in the appropriate label condition ($M = .4$, $SD = .1$) was higher than performance in the nonwords condition ($M = .28$, $SD = .09$). The main effect of cueing was significant, $F(1, 5) = 7.38$, $p < .05$, $MSe = .005$, $\eta^2 p = .6$. Performance on cueing conditions ($M = .38$, $SD = .1$) was higher than performance on no cueing conditions ($M = .3$, $SD = .1$; although the main effect of cueing was not evident in the analyses by-participants, F^2 (1, 76) = 2.25, *p* = ns. The effects of label type did not interact with cue type, *F* (1, 5) = .08, *p* = ns.

Additionally, it was aimed to examine the effect of presenting experimenter-generated labels during encoding compared to spontaneous naming, which was expected to occur in the control condition. A repeated measures ANOVA between the control condition, appropriate labels with no cues and nonwords with no cues revealed a significant effect of label type, *F* (2, 10) = 11.28, $p < .01$, *MSe* = .004, η^2p= .69 (which was marginally significant by-subjects, F^2 (2, 57) = 3.12, *p* = .05, *MSe* = .05, η^2p= .1). Post hoc comparisons using the Tukey HSD test indicated that performance for the control condition (*M* = .42, *SD* = .14) was not significantly higher than appropriate labels with no cues condition (*M* = .35, *SD* = .09), *p* = ns. Additionally, the control condition (*M* = .42, *SD* = .14) was not significantly higher than nonwords with no cues condition (*M* = .25, *SD* = .11), *p* = ns. Finally, performance for appropriate labels with no cues condition (*M* = .35, *SD* = .09) was not significantly higher than the nonwords with no cues condition (*M* = .25, *SD* = .11), *p* = ns.

As mentioned in the introduction, based on the pair association account, it was expected to find a detriment of appropriate labels with no cues compared to the control condition, but that this detriment would not be at the same level as that associated with nonwords at encoding with no cues. Therefore, difference scores were explored by calculating the differences in the means between the control condition and each of appropriate labels with no cues and nonwords with no cues. A repeated measures ANOVA showed a significant main effect of the label type on the size of differences from the control condition, *F* (1, 5) = 24.76, $p < .01$, *MSe* = .001, η^2p= .83 (however, this effect was not significant by-participant, F^2 (1, 38) = 1.1, *p* =

ns). The size of difference from the control condition was larger for nonwords with no cues (*M* = .17, *SD* = .12) compared to appropriate labels with no cues (*M* = .07, *SD* = .09). This indicated that performance in the mental rotation task descended proportionally from the control condition (highest) to appropriate label with no cues condition (middle) to the nonwords with no cues condition (lowest).

Furthermore, it was aimed to examine whether the cues can improve performance to the level of the control condition. Overall, a one way repeated measures ANOVA between the control condition, appropriate cues and nonwords cues revealed no significant effect of cue type, F (2, 10) = 2.83, p = ns. Nevertheless, given that a difference between presenting appropriate labels and nonwords labels as cues at retrieval may be expected additional exploratory analyses were conducted. Difference scores were explored by calculating the differences in the means between the control condition and each of appropriate labels with cues and nonwords with cues. A repeated measures ANOVA showed a significant main effect of the label type on the size of differences from the control condition, F (1, 5) = 7.85, $p < .05$, *MSe* = .01, $\eta^2 p$= .61 (although this effect was not significant by-participants, F^2 (1, 38) = 1.27, p = ns). The size of difference from the control condition was larger for nonwords with cues (*M* = .1, *SD* = .14) compared to appropriate labels with cues (*M* = - .02, *SD* = .14).

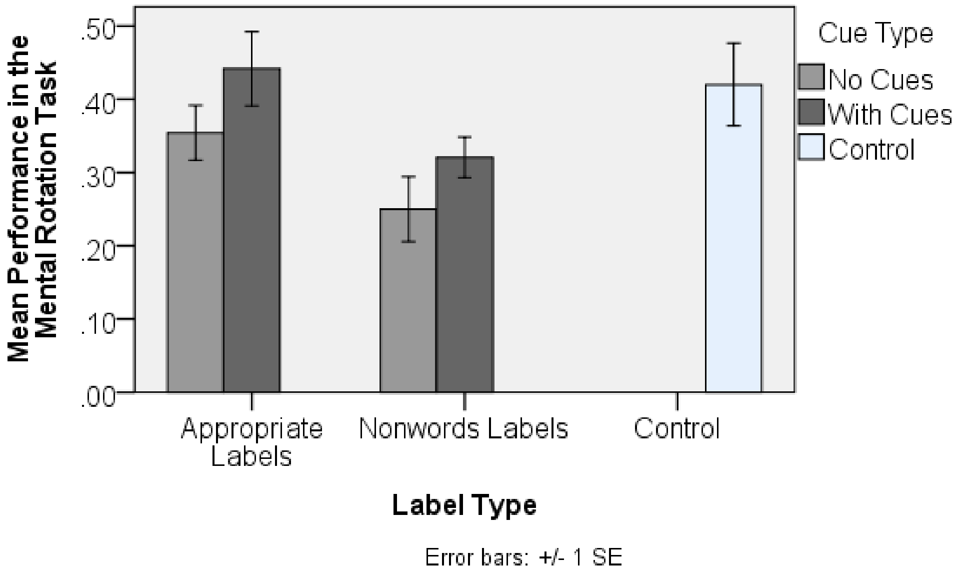


Figure 12. Performance in the rotation task in Experiment 5, expressed by the proportion correct score for items in each condition.

Discussion

Experiment 5 moved from manipulating self-generated labelling to experimenter-generated labelling on easy-to-name shapes. It examined whether experimenter-generated labels impair imagery performance in a temporal context and whether the effects of verbal labels would differ in magnitude depending on the extent to which they readily match with the shapes. This was achieved by comparing imagery performance after presenting the shapes with or without experimenter-generated appropriate labels or nonwords during encoding. Additionally, it was aimed to examine whether providing verbal cues at retrieval can remove the impairing effect and improve performance. The results illustrated that appropriate labels were associated with higher performance compared to performance associated with nonwords, but only when collapsing labelling at encoding only with cueing conditions. Another finding was that applying experimenter-generated labels below the shapes when presenting them to participants during encoding generally impaired performance compared to the spontaneous naming condition. However, using appropriate labels showed less impairment compared to nonwords labels. Additionally, this impairment caused by experimenter-generated labels was attenuated by re-presenting the verbal labels as cues at retrieval, and hence, re-instating performance to the level of the control condition (for both the appropriate and nonwords label conditions). These findings are discussed below, taking into account that the explicit labelling effect is influenced by the temporal presentation method used in this experiment.

These effects of explicit naming in the temporal presentation method cannot be explained with the shift in emphasis accounts. According to the shift in emphasis accounts verbal labels that are related to global or prototypical pictures would have stronger impairing effects on memory (Lupyan, 2008). However, the findings from Experiment 5 revealed lower performance for the nonword labels compared to appropriate labels. In addition, re-presenting such verbal labels, which do not correspond to features of the shapes, cannot improve imagery performance in the view of the shift in emphasis accounts (Brandimonte & Collina, 2008). Nevertheless, the findings demonstrated that cueing memory with the verbal labels removed interference and improved performance to the level of the control condition. This suggests that the mechanisms of verbal interference within visual memory in the temporal presentation method may differ from the mechanisms in the spatial-temporal presentation method. Further discussion of this difference is provided in the final chapter of this thesis.

The findings indicated that appropriate labels showed a smaller (albeit non-significant) impairing effect compared to the control condition whereas nonwords labels revealed a larger (albeit non-significant) impairing effect compared to the control condition. This was found by the significant difference between the size of difference from the control condition which showed a larger difference for the nonwords with no cues compared to the difference for the appropriate labels with no cues. An applicable explanation for such effects comes from pair association studies, which indicate that presenting shapes alongside labels requires creating associative pairs in memory (Verhaeghen et al., 2006), and that forgetting a member from a pair impairs memory for the whole pair (Hockley & Bancroft, 2011). Nonwords are more likely to be forgotten compared to common words (Greene, 2004; Xu & Malmberg, 2007). Thus memory of shapes associated with nonwords is lower than memory of shapes associated with common words. This suggests that the match between the verbal label presented alongside the shape and the shape itself influences subsequent visual memory. Additionally , the beneficial effect of cueing suggests that verbal-visual associations have been successfully created. Therefore, re-presenting the verbal labels as cues at retrieval can remove the impairment and improve performance to the level of the control condition. Additionally, it was predicted, based on the pair association account that appropriate cues might show larger improvement compared to nonwords cues as they create stronger associations with the shapes. The results, however, did not provide enough evidence for this prediction. Here both appropriate labels and nonwords when used as cues improved performance to the level of the control condition. This issue will be re-visited in Chapter 7.

The general detriment in encoding account implies that improvement for memory can, occasionally, be found after re-presenting verbal cues at retrieval. This prediction is not inconsistent with the findings of a positive effect of cueing. However, such account suggests that presenting any type of verbal labels during encoding can impair performance. The results showed larger impairment by nonwords compared to appropriate labels. Thus, the detriment in encoding account cannot fully explain the findings of Experiment 5. Additionally, the detriment in encoding account cannot still be considered an explanation for the larger impairing effect of nonwords at encoding. Although nonwords were novel to participants and one may suggest that they drew participants' attention away from encoding the shapes, the results showed a main positive effect of cueing with no significant interaction between the cueing effect and label type. This indicates that participants were able to encode the shapes even when they were presented with nonwords.

However, one may refer any positive effect of verbal cues to the beneficial effect of context reinstatement on memory. That is when labels are presented at encoding and these same labels are again presented at retrieval, memory performance will be enhanced (Weiss & Margollus, 1954; Murnane & Phelps, 1993; Murnane & Phelps, 1995; Dougal & Rotello, 1999). Whatever explanation is applicable, providing verbal cues at retrieval removed the impairing effect of explicit labelling, and this is consistent with the pair association account.

In summary, Experiment 5 examined the effect of experimenter-generated labels on easy-to-name shapes within the temporal presentation method. Additionally, it examined the effect of verbal cues at retrieval. The results did show an important effect for the match between the verbal code and the shape by showing higher performance for appropriate labels compared to nonwords when collapsing across labels with no cues and labels with cues conditions. Another finding was the impairing effect of presenting experimenter-generated labels at encoding compared to a control condition where it is assumed that spontaneous naming occurred. This negative effect might be due to pair association effects, which does not allow access to the shape unless the participant accessed the whole pair (i.e., both the shape and its corresponding label). This assumption was supported by finding a larger detriment on performance when nonwords labels, that are difficult to recall (Greene, 2004; Xu & Malmberg, 2007), were associated with the shapes than when appropriate labels were associated with the shapes. Additionally, re-presenting the verbal labels as cues helped performance, and this is also consistent with a pair association account.

Conclusion

Together, the findings from Experiments 4 and 5 indicate that the effects of explicit labelling, both self-generated or experimenter-generated, impair performance in the temporal presentation method, and this may suggest that a similar mechanism underlies both self-generated and experimenter-generated labels. The impairing effects of explicit labels are different from the effect of spontaneous naming in the temporal presentation method. Preventing spontaneous naming through the use of concurrent verbal tasks disrupts performance (Experiments 1 and 2), but so does encouraging verbal naming through explicit instruction or presentation of labels (Experiment 4 and 5). These findings are different from those observed using spatial-temporal presentation methods, where both explicit labelling and covert spontaneous naming impair performance. The verbal interference effect found in the spatial-temporal presentation method was explained by the shift in emphasis accounts. In contrast, the impairing effect caused by explicit labelling in the temporal presentation method is best explained by the pair association account. The differences between the temporal presentation and the spatial-temporal presentation method in mediating the effects of verbal labelling will be discussed in the final chapter of this thesis.

Chapter 6: Time and Number of Exposures to Experimenter-generated Labels and Verbal Interference

Experiment 6

Introduction

Experiments 4 and 5 in this thesis used explicit labelling during encoding and demonstrated verbal interference effects via explicit labelling in the temporal presentation method. The findings from Experiment 4 and 5 favored the pair association theory, which suggests that presenting the labels alongside the shapes creates verbal-visual associations, and hence, remembering one item from a pair required retrieval of the whole pair (Hockley & Bancroft, 2011). Therefore, creating the verbal-visual associations impaired imagery performance, under conditions where no verbal labels were provided as cues at retrieval, because people were more likely to forget the labels compared to pictures (Ally & Budson, 2007; Nelson et al., 1976; Shepard, 1967).

Experiment 4 and 5 in this thesis, using the temporal presentation method, has examined the effect of explicit labelling during encoding under conditions where labels are always presented alongside shapes. That is, the cycle of shape presentation was repeated for three rounds, where each shape was consistently presented for a certain period each round (five seconds), and each verbal label was presented alongside the corresponding shapes during all three rounds of presentations. In order to further explore the mechanisms underlying the negative effect of labelling during encoding, it is of value to manipulate the frequency and timing of label presentation. Reducing the number of presentations of the verbal labels (e.g. from three exposures to one exposure, so that the shapes are presented for three rounds, but the verbal labels are presented at only one round) may weaken the verbal-visual association. This is according to studies which have indicated that forming associate pairs is an incremental process. These studies have shown that repetition is required to strengthen association of the pairs (Battig, 1962; Postman, 1962).

In addition, duration for which the labels are presented seems to be important. Reducing the number of presentations of the verbal labels reduces the time of exposure to the label-picture pairs. Reduction of time of exposure to the label-picture pair may not allow for the successful formation of the verbal-visual association. This is because verbal labels are not immediately associated with the shapes after exposure to the label-picture pair, but require a certain time to successfully form the association (Verhaeghen et al., 2006). Work by Verhaeghen et al. provides support for this. They compared performance in a recognition test when the pictures were presented alone during encoding with performance when the pictures were presented with verbal labels during encoding, and the same labels were used as cues at retrieval. They also manipulated the time of exposure during encoding, which varied between 800ms and 3200ms. The results showed that performance on the cued test, where labels were presented alongside the pictures during encoding, was lower than performance in the picture only test when the time of exposure to the stimuli during encoding was shorter (800ms). This may indicate that the time of exposure was not adequate to form a verbal picture pair for the condition where labels were presented with the pictures during encoding. Longer time of exposure (3200ms) increased the level of performance in the cued conditions, and performance in the cued conditions became higher than performance in the picture only condition. This suggests that the time of exposure in this condition was adequate to allow for successful formation of the label-picture pair and to make cues beneficial at retrieval.

According to the pair association account, it may be expected that the verbal label does not impair memory of the picture unless a visual-verbal association is created. Hence, if reducing the number and time of exposure to the label-picture pairs impairs the formation of verbal-visual associations, then it would be expected that the interfering effect of explicit verbal labels, previously found in the temporal presentation method, would not be shown due to the absence of the adequate formation of verbal-visual associations.

In contrast, pair association might be an all-or-none process, implying that the pair association can be formed by one exposure to the pair, and that repetition does not increase the strength of the pair association (Clark, Lansford & Dallenbach, 1960; Rock, 1957). Hence, reduction of number and time of exposures to the label-picture pairs may neither affect successful formation of verbal-visual associations nor remove the interfering effect of explicit labels. Therefore, Experiment 6 set up a preliminary attempt to examine whether the interfering effect of explicit labelling can still be observed after reducing the number and conjointly time of exposures to the verbal labels.

Additionally, evidence from previous studies that used verbal description (e.g., Huff & Schwan, 2008) or verbal labels (Verhaeghen et al., 2006) indicate that the time when verbalization occurs moderates the effects of the verbalization on visual memory. Of particular relevance to the present study Verhaeghen et al., (2006) examined the effect of verbal labels when presented before and after the encoding of visual stimuli (Chinese characters). They demonstrated that visual recognition benefits from verbal cues at retrieval, when these cues had been previously presented as labels before the presentation of the pictures during encoding. In contrast, recognition was not enhanced by verbal cues when these cues were previously presented as labels after the presentation of the pictures during encoding. Verhaeghen et al. explained that verbal cues benefited performance, under the condition were verbal labels proceeded the shapes, because verbal labels were used to search for a feature from the shape that matched the label, and this allowed successful formation of the verbal-visual association. On the other hand, verbal cues did not enhance performance in the condition where verbal labels followed the pictures during encoding because participants were extracting any part of the to-be-remembered picture to be adapted and matched with the label. Changing features of the pictures to be matched with the labels disrupted the visual representation of the picture and failed to create an accurate verbal-visual association that could later be effectively used during retrieval. It may rather cause a retroactive interference effect. That is newly learned information may interfere with previous information when they refer to similar contents (Adaval & Wyer, 2004; Deutsch, 1974; Massaro, 1970).

Verhaeghen et al. did not examine recognition performance when verbal labels were presented during the encoding of the shapes but were not presented again as verbal cues during the recognition test. However, predictions can be made based on the pair association account. The formation of a verbal-visual association may cause interference via explicit labelling, when the labels are presented at encoding but are not re-presented as cues at retrieval. Based on this view, presenting the verbal label early during encoding may create a verbal-visual association, which shows an interfering effect under conditions where no verbal cues were provided at retrieval. Presenting the verbal label after initially encoding the picture, however, may lead to a weaker or no verbal-visual association being formed, and in this case may not show an interfering effect. However, in this instance, a retroactive interference effect may be observed. This is because learning new stimuli can interfere with access to previously learned stimuli. In this case, learning the verbal labels interferes with the ability to access information about the pictorial stimuli (Adaval & Wyer, 2004; Deutsch, 1974; Massaro, 1970).

Experiment 6, presented the shapes for three rounds of presentations and allowed exposure to the verbal labels during only one round of the presentation. It additionally examined the effect of presenting experimenter-generated labels, both appropriate labels and nonwords, at the first presentation of the shapes vs. presenting the experimenter-generated labels at the last presentation of the shapes. In addition, performance in the labelling conditions was compared with performance in a control condition (a no label condition). It may be expected that there would be an interfering effect via presenting labels at the first round of presentation during encoding if a verbal-visual association is formed from a single presentation (Clark et al., 1960; Rock, 1957). In contrast, no interference via presenting verbal labels at the first presentation should occur if repeated presentation is needed to form the verbal-visual association (Battig, 1962; Postman, 1962). Finally, labels that are presented at the third, and last, round of presentation may form weaker or no verbal-visual associations. This predicts that a detriment in performance may not be found. However, presenting the verbal labels at the third presentation may cause a retroactive interference effect and show a detriment in performance (Deutsch, 1974; Massaro, 1970).

Hence, two patterns of results were expected based on whether verbal-visual associations are formed or not via one exposure to the labels during encoding. First, if verbal-visual associations cannot be formed from one exposure to the label-picture pair, then the findings would not show an interfering effect of appropriate labels and nonwords at the first round of presentation compared to the control condition. However, appropriate labels and nonwords at the third presentation may show impairing effects compared to the control condition due to the retroactive interfering effect (Deutsch, 1974; Massaro, 1970). In this case, the impairing effect by appropriate labels at the third round of presentation may be less than the impairing effect by nonwords at the third round of presentation. This may be because appropriate labels compared to nonwords have been found to show less demands on memory and, hence, less interference with the memory of previously learned items (McKone, 1995). Alternatively, the account by Lupyan (2008), predicts that the negative effect of appropriate labels may be larger than the negative effect of nonwords because appropriate labels are more closely matched with the prototypical picture of the label and can create a larger shift to match the prototypical image. Second, if verbal-visual associations are formed, then the pattern of results may be similar to the results of Experiment 5, which presented appropriate labels and nonwords during all rounds of presentation during encoding and showed an interfering effect of both appropriate labels and nonwords, with a larger impairing effect for nonwords compared to appropriate labels. Hence, findings from Experiment 6 may show interfering effects for performance in both appropriate labels at first presentation and nonwords at first presentation because they both allow for formation of verbal-visual associations. Here the negative effect of nonwords is expected to be larger than the effect of appropriate labels, similar to findings from Experiment 5. Appropriate labels and nonwords at the last presentation may not show impairing effects compared to the control condition, if they form weak or no verbal-visual associations. They, however, may show the impairing effect because, as described above, they may cause retroactive interference effects (Deutsch, 1974; Massaro, 1970).

Participants

One hundred healthy adults, (76 females, 24 males), age-ranged 18-36 (mean 22 years and 3 months), were recruited from the University of Leeds. All participants had normal or correct-to-normal vision, were native English speakers, and had not participated in any of the previous experiments that used the mental rotation paradigm. All participants gave their informed consent prior to the experiment, and were paid a small amount of money in return for their participation.

Materials

The materials were the same as those used in Experiment 5. They were six easy-to-name shapes and a practice shape, presented as black drawings in the centre of a white screen.

The appropriate names were the agreed names from Brandimonte et al. (1992a) naming agreement test, and nonwords were those previously used in Experiment 5 and were generated by using nonwords generator software (http://www.maccs.mq.edu.au) (Rastle et al., 2002). The same nonword always appeared with the same shape across all participants, and each nonword was matched to the appropriate name in terms of number of letters.

Design and Procedures

The design was a 2 (label type: appropriate labels vs. nonwords) x 2 (time of labelling: first presentation vs. third presentation) between-subjects factorial design, in addition to the control group, where no labels were presented. Participants' were randomly assigned to one of the five groups, each had 20 participants: (control, appropriate labels at first presentation, appropriate labels at third presentation, nonwords labels at first presentation, and nonwords labels at third presentation). The dependent variable was the number of letters correctly identified out of 12 responses in the mental imagery task. The procedures were as same as those in Experiment 5. The six shapes were presented one after the other, at a rate of five seconds each, on a computer screen three times in total. The order of shapes was the same across the three rounds of presentation, and the order of shapes was varied across participants. After learning the shapes, participants were informed about the image manipulation task and were allowed to practice it, and then performed the imagery task. Participants were asked to recall the shapes one after the other in their order. There was a five-second waiting screen before participants recalled each shape. A tone after this waiting screen indicated to participants that they could start generating an image of the shape in order to perform the mental rotation task and discover the hidden letters in each shape.

Participants in the labelling conditions were shown either appropriate labels or nonwords in a black font one centimetre below the shapes. Participants in the appropriate labels at first presentation and nonwords at first presentation conditions were shown the labels only at the first presentation of the stimuli. Participants in the appropriate labels at third presentation and nonwords at third presentation were shown the labels only at the third presentation of the stimuli. No further instruction was given to participants in the labelling conditions in respect of labels, and participants did not expect to view the labels alongside the shapes.

Results

A proportionally corrected score for each item was calculated by dividing the number of correct letters in each response by the number of possible correct answers. As there were two correct answers for each shape, participants' responses were scored as 0, .5, or 1 when they gave 0, 1, or 2 correct letters, respectively. Then, within each condition participants responses were pooled to provide a mean proportion correct score for each item. See Figure 13 for the mean proportional correct scores for each condition. Analyses by- participants provided a similar pattern of results, and therefore, are reported in Appendix I. However, it will be highlighted when differences between the by-items and by-participants analyses arise. The *F* values for participant analyses, when presented in this chapter, will be named F^2.

A 2 (label type: appropriate labels vs. nonwords) x 2 (time of presentation of labels: labels at first presentation vs. labels at third presentation) repeated measures analysis of variance (ANOVA) revealed that there was no significant main effect of label type on participants performance in the rotation task, F (1,5) = .001, p = ns. Performance in the appropriate label condition (M = .31, SD = .09) was not different from performance in the nonwords condition (M = .31, SD = .09). The main effect of time of presenting labels was marginally significant, F (1, 5) = 4.79, p = .08, MSe = .003, η^2p= .49. There was a trend towards better performance in the labels at first presentation condition (M = .34, SD = .2) than the labels at third presentation condition (M = .29, SD = .08; although this was not evident in the analyses by-participants, F^2 (1, 76) = .94, p = ns). The effects of label type showed a significant interaction with time of presentation of labels, F (1, 5) = 9.47, $p < .05$, MSe = .003, η^2p= .65 (however, the interaction was not significant in analyses by- participants, F^2 (1, 76) = 1.93, p = ns).

Further analyses by a dependent sample *t*-test between the appropriate labels at first presentation (M = .32, SD = .09) and appropriate labels at third presentation

(M = .3, SD = .09) showed no significant difference between the two conditions, t (5) = .54, p = ns. However, a dependent sample t test between the nonwords at first presentation (M = .37, SD = .11) and nonwords at third presentation (M = .25, SD = .08) showed significantly lower performance for nonwords at third presentation compared to nonwords at first presentation, t (5) = 3.66, $p < .05$, effect size (Cohen's d) = 1.25, observed power = .37. Additionally, a dependent sample t test showed no significant difference between appropriate labels at first presentation and nonwords at first presentation, t (5) = 2.35, p = ns. Finally, a dependent sample t test showed no significant difference between appropriate labels at third presentation and nonwords at third presentation, t (5) = 1.64, p = ns.

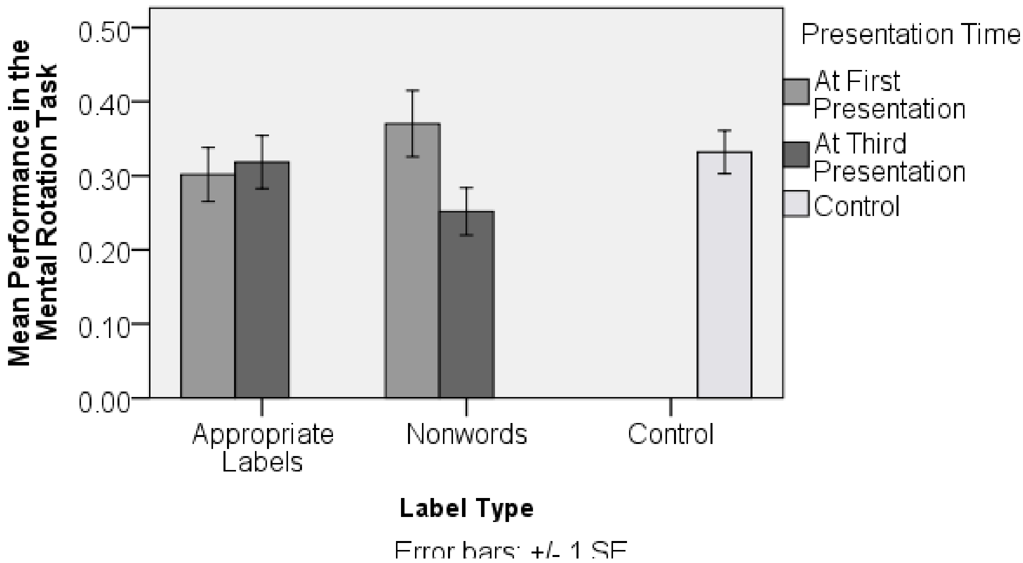


Figure 13. Performance in the rotation task in Experiment 6, expressed by the proportion correct score for items in each condition.

A series of dependent t tests revealed that the control condition (M = .33, SD = .07) was not significantly different from appropriate labels at first presentation (M = .3, SD = .09), t (5) = .99, p = ns, appropriate labels at third presentation (M = .32, SD = .09), t (5) = .56, p = ns, nonwords at first presentation (M = .37, SD = .11), t (5) = 1.39, p = ns. However, the control condition (M = .33, SD = .07) was marginally different from nonwords at third presentation (*M* = .25, *SD* = .08), *t* (5) = 2.5, *p* = .055, effect size (Cohen's d) = 1.06, observed power = .29 (however, this effect was not significant in analyses by-participants, *t* (38) = 1.19, *p* = ns).

Discussion

The aim of Experiment 6 was to examine whether the verbal interfering effect via explicit labels found in Experiments 4 and 5 can still be observed after reducing the number of exposures to the verbal labels. Additionally, it was aimed to examine whether the time of presenting experimenter-generated labels can determine the interfering effect via experimenter-generated labels on imagery performance. Experiment 6 presented the shapes for three rounds during encoding and examined the effect of presenting appropriate labels and nonwords at either the first round of presentation or the third and last round of presentation.

The results showed a significant interaction between label type and time of presentation of labels. Nonwords at third presentation impaired imagery performance compared to the nonwords at first presentation condition. In addition, the nonwords at third presentation condition showed marginally lower performance compared to the control condition whereas performance in the nonwords at first presentation condition was not significantly different from the control condition. In contrast, performance in the conditions viewing appropriate labels at first presentation and appropriate labels at third presentation neither differed from each other, nor differed from the control condition. These findings suggest that reduction of exposure to verbal labels may impair the creation of verbal-visual association and, hence, remove the interfering effects of explicit labelling during encoding. In addition, they show that the time when labels are presented during encoding has an impact on imagery performance.

These findings may be consistent with the view that forming verbal-visual association is an incremental process and that repetition may increase the strength of verbal-visual associations (Battig, 1962; Postman, 1962). It is apparent that the effects of explicit labelling appear to be less robust in Experiment 6. In particular, appropriate labels given at encoding no longer clearly outperformed nonwords.

In addition, the findings showed that the time of presentation is important. For instance, nonwords impaired performance when presented at the third round of presentation, but did not impair performance when presented at the first round of presentation. These findings are somewhat consistent with those of Verhaeghen et al. (2006) that showed lower performance by manipulating verbal labels after viewing the pictures as opposed to manipulating verbal labels before viewing the pictures. Presenting experimenter-generated labels before the shapes were thought to allow participants to effectively match features from the shapes to the labels. In contrast, presenting experimenter-generated labels alongside the last presentation of the shapes may have led to retroactive interference that then impacted upon imagery performance. This can be a result of learning the labels after being first exposed to the pictures, and hence, learning the labels may interfere with access to the pictures (Deutsch, 1974; Massaro, 1970). The impairing effect of presenting labels at the last round of presentation during encoding was only evidenced for nonwords. This may be because learning nonwords requires a larger effort and hence shows larger interference with memory of previously learned shapes (McKone, 1995).

Overall, Experiment 6 showed that reducing the number of exposure to the label-picture pairs may not allow the creation of the verbal-visual association and, hence, minimizes the verbal interference effect. This might imply that increasing the number of exposures to the label-picture pairs can strengthen the verbal-visual association. This will be examined in Experiment 8 which will increase the number of presentations of the label-picture pairs in order to strengthen the verbal-visual association and the interfering effect of explicit labels. Additionally, Experiment 6 showed that the time-point at which verbal labels are presented alongside the shapes can determine the negative effect of these labels on visual memory. This issue will not be pursued further in this thesis, but it is a useful starting point for future research.

Chapter 7: The Role of Spontaneous Naming and Explicit Labelling in a New Mental Subtraction Paradigm

Introduction

Experiments in this thesis, so far, used the mental rotation paradigm. They demonstrated verbal facilitation effects via spontaneous naming (Experiments 1 and 2) and verbal interference effects via explicit labelling (Experiments 4 and 5) in the same temporal presentation method. However, it is important to replicate the previous findings from the thesis in a different paradigm. This will indicate whether the results from the mental rotation paradigm are generalized to other imagery paradigms. Therefore, two experiments (Experiment 7 and 8) that used an alternative imagery paradigm, a newly developed imagery subtraction task, will be presented in Chapter 7. The aim of including these two experiments were to replicate the positive effects of spontaneous naming through the use of AS at encoding (Experiment 7), and to replicate the interfering effects of explicit labelling through the use of experimenter-generated labels at encoding (Experiment 8).

Previously, studies using mental subtraction paradigms (Brandimonte et al., 1992b; Pelizzon et al., 1999) have only used the spatial-temporal presentation method. The effects of verbalization in these studies were consistent with findings from the mental rotation paradigm which used the spatial-temporal presentation method (e. g., Brandimonte et al., 1992a; Brandimonte et al., 1997; Pelizzon et al., 2002; Brandimonte & Collina, 2008). Thus, it was expected that findings from the mental rotation paradigm that used the temporal presentation method in this thesis can be replicated by the imagery subtraction paradigm when using the temporal presentation method. The new mental subtraction task used in Experiment 7 and 8 involves removing a section (top, bottom, left, or right) from the memorized shape in order to discover an embedded letter or number. It differs from previous imagery subtraction paradigms (e. g., Brandimonte et al., 1992b; Pelizzon et al., 1999), where a picture of a part from each shape was presented at retrieval, and participants were asked to extract the picture of the part from the whole image and identify the answer. In the new subtraction paradigm, it was aimed to avoid presenting visual items at retrieval. Presenting pictures of the parts to be removed might discourage the use of the verbal code. The stimulus set used in the new mental subtraction task also differed from those used in previous mental subtraction tasks. In previous experiments the sets of stimuli revealed different types of items after mental subtraction. In those studies, the easy-to-name shapes revealed pictures of objects after subtraction. In contrast, hard-to-name shapes revealed English letters from the alphabet. Identifying letters and pictures may involve different underlying cognitive processes. For example, a neuroimaging study showed distinct functional brain areas for identifying letters and identifying pictures (Vandenberghe, Price, Wise, Josephs & Frackowiak, 1996). Therefore, it was aimed to use a set of easy-to-name and hard-to-name shapes that both reveal letters from the alphabet or numbers.

Experiment 7

Introduction

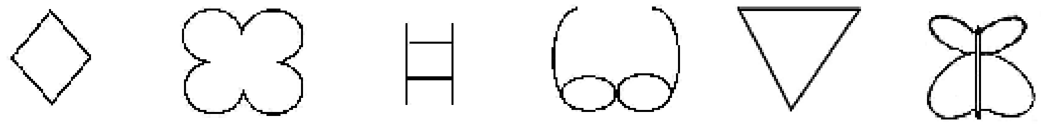
Experiment 7 aimed to replicate the effects of spontaneous naming in the temporal presentation method. It compared performance on easy-to-name and hard-to-name shapes and used AS during encoding. Based on the finding from the temporal presentation method in the mental rotation paradigm (Experiment 1 and 2), it was expected to find higher performance for easy-to-name shapes compared to performance on hard-to-name shapes. Additionally, it was expected that spontaneous naming would improve performance. Thus, AS would suppress the positive effect of spontaneous naming and would impair performance in both types of shapes. This would show a lower performance in the AS at encoding compared to the control condition, where no AS was used. There are several accounts that tried to explain the positive role of spontaneous naming. One group of accounts suggest that the positive effects of spontaneous naming may arise because spontaneous naming might help to strengthen the encoding of the shapes by deepening semantic processing of the shapes (Daniel & Toglia, 1976; Ellis, 1968) or by integrating the features of the shapes into single units (Santa, 1975). A different group of accounts suggest that spontaneous naming can help to encode verbal information alongside the shapes and, hence, can cue visual memory of the shapes (Bahrick & Bahrick, 1971). Alternative accounts assume that the role of spontaneous naming is related to encoding the order of the shapes (Pelizzon et al., 2002; Poirier et al., 2007). The findings from Experiments 1, 2 and 3 in this thesis provide new information about the role that verbal code plays in visual memory when temporal information is emphasized. They indicate that verbal information was used at encoding and was used again at retrieval (Bahrick & Bahrick, 1971), and that the role of the spontaneous naming may be related to processing of the order of the shapes (Pelizzon et al., 2002; Poirier et al., 2007).

Participants

One hundred healthy, adults and native English speakers (80 females, 20 males), age range 18-37 (mean = 22 years and 10 months) were recruited from the University of Leeds. Participants were assigned to four groups, 25 participants each. All participants gave their informed consent prior to the experiment, and were paid a small amount of money in return for their participation.

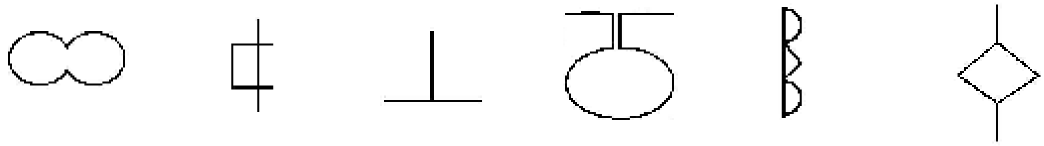
Materials

The stimuli included six easy-to-name shapes, six hard-to-name shapes, and two shapes for the practice trial. When half of a shape is removed, either an English capital letter or a number is revealed. For each shape, there was only one correct answer. See Figure 14 for the easy-to-name shapes, the segments that were removed, and the correct answers, Figure 15 for hard-to-name shapes and Figure 16 for the training shapes. Half of the shapes consisted of straight lines, and half contained curved lines. The shapes were classified as easy-to-name and hard-to-name shapes after performing a naming agreement test, where 21 participants, who did not participate in the main experiment, were asked to name the shapes. This follows the procedure used by Brandimonte et al. (1992a) for classifying shapes. Shapes that received 50% agreement on their names are described as easy-to-name shapes. See Table 5 for the names, and numbers of participants agreed on the name, for each shape listed in the same order presented in Figure 14 and Figure 15. The stimuli were presented on a 16 inch white computer screen, where each shape appeared as a black line drawing, approximately 12 cm height x 12 cm width, in the centre of the screen. No borders were drawn around the shapes, so they appeared on a larger white background.



Remove the top half	Remove the left half	Remove the top half	Remove the right half	Remove the left half	Remove the left half
'V'	'3'	'H'	'6'	'7'	'B'

Figure 14. The six easy-to-name shapes, the halves that should be removed and the correct answer for each shape in the mental subtraction paradigm.



Remove the right half	Remove the top half	Remove the left half	Remove the left half	Remove the bottom half	Remove the top half
'C'	'4'	'L'	'5'	'R'	'Y'

Figure 15. The six hard-to-name shapes, the halves that should be removed and the correct answer for each shape in the mental subtraction paradigm.

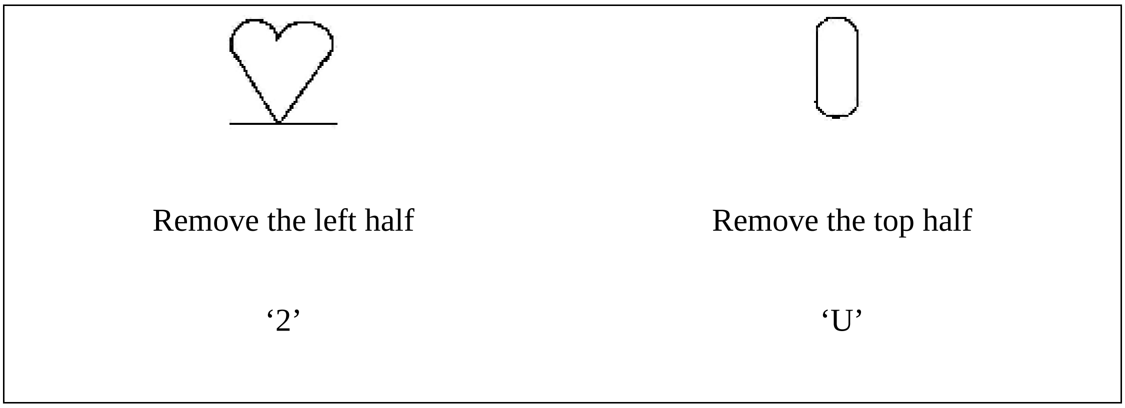


Figure 16. The training shapes, the halves that should be removed, and the correct answer for each shape in the mental subtraction paradigm.

Table 5. Names and numbers of participants agreed on the names for easy-to-name and hard-to-name shapes for the mental subtraction task.

Shape Type	*Shape*	*Name*	*% of Participants Agreed on the Name*
Easy-to-name shapes	1	Diamond	86%
	2	Flower	90%
	3	Ladder	90%
	4	Glasses	81%
	5	Triangle	76%
	6	Butterfly	95%
Hard-to-name shapes	1	Two circles	10%
	2	No name was given	53%
	3	No name was given	19%
	4	No name was given	29%
	5	No name was given	48%
	6	No name was given	33%

Design and Procedures

The design was a 2 (shape type: easy-to-name vs. hard-to-name shapes) x 2 (control vs. AS at encoding) between-subjects factorial design. Participants were randomly assigned to one of the four groups (easy-to-name shapes control, easy-to-name shapes with AS at encoding, hard-to-name shapes control, or hard-to-name shapes with AS at encoding). Each group had 25 participants. The dependent variable was the number of letters/numbers correctly identified in each condition.

The procedures of the learning phase were the same as those used in Experiments 2, 4, 5 and 6. The six shapes were presented sequentially, five seconds each, on a computer screen three times in total, and participants were asked to memorize the shapes. The order of shapes was the same for all three rounds of presentation, and it was varied across participants. Participants in the AS conditions were given further instructions that they should carry on counting out loud from (1-4) at a constant rate of two digits per second whilst viewing the shapes.

A training phase followed the presentation phase. In the training phase, participants were shown two training shapes (one containing a letter and one containing a number) and they were told that when they removed a half of each shape, they would get a letter/number. Participants, then, were informed about the retrieval task and were able practice it using the same training shapes.

Then participants did the subtraction task with the six shapes in order (i. e. first shape = first trial, and so on). In the retrieval phase, a fixation cross was exposed in the centre of the screen for five seconds, at the beginning of each trial. Participants were asked to wait and to not start the subtraction task until they heard a tone. A sentence appeared on the screen, after the tone of each trial, telling participants what segment they should mentally remove from the shape (e. g., remove the left half of the shape). As soon as participants read the sentence, they performed the subtraction task, typed the letter/number, and then pressed the SpaceBar to move to the next trial. All participants were allowed to spend as much time as needed in each trial. In the case that participants could not identify the letter/number, they were told to press the return key on the keyboard. After participants performed their task with all the shapes, they were debriefed about whether they named the shapes to memorize them, and whether they had identified some of the embedded letters/numbers before they were told about them. All participants in easy-to-name conditions reported having named the shapes to memorize them, and had not identified the letters/numbers before they were told about them. Participants in hard-to-name conditions used a mixture of strategies to memorize the shapes (e. g., naming, matching with similar items etc.), and three participants identified the letters/numbers before they were told about them. Participants who identified the letters/numbers during the presentation phase were eliminated from the study and were replaced by new participants.

Results

As there was one correct answer for each shape, participants' responses were scored as 0 when they gave an incorrect answer or 1 when they gave a correct answer. Within each condition participants responses were then pooled to provide a mean proportion correct score for each item. Figure 17 presents the mean proportion correct scores for each condition. Analyses by-participants provide a similar pattern of results, and therefore, are reported in Appendix J. However, it will be highlighted when differences between the by-items and by-participants analyses arise. The F values for participant analyses, when presented in the chapter, will be labelled as F^2.

A 2 (shape type: easy-to-name shapes vs. hard-to-name shapes) x 2 (concurrent task: control condition vs. AS at encoding) mixed factorial analysis of variance (ANOVA), having shape type as a between group factor and concurrent task as a within group factor was carried out on the mean proportion correct scores obtained in the mental subtraction task. This revealed no significant effect of shape type on participants performance by-items, F (1, 10) = 2.77, p = ns. However, analyses by-participants did show a significant main effect of shape type, F^2 (1, 96) = 4.01, $p < .05$, *MSe* = .09, $\eta^2 p$= .04. Performance for the easy-to-name shapes (M = .63, SD = .29) was higher than performance for the hard-to-name shapes (M = .51, SD = .33). By-items, the main effect of AS at encoding was significant F (1, 10) = 16.4, $p < .01$, *MSe* = .01, $\eta^2 p$= *.62*. Performance in the AS at encoding condition (M = .48, SD = .18) was significantly lower than performance in the control condition (M = .65, SD =.11). The effects of shape type did not interact with the concurrent task, F (1, 10) = .01, p = ns.

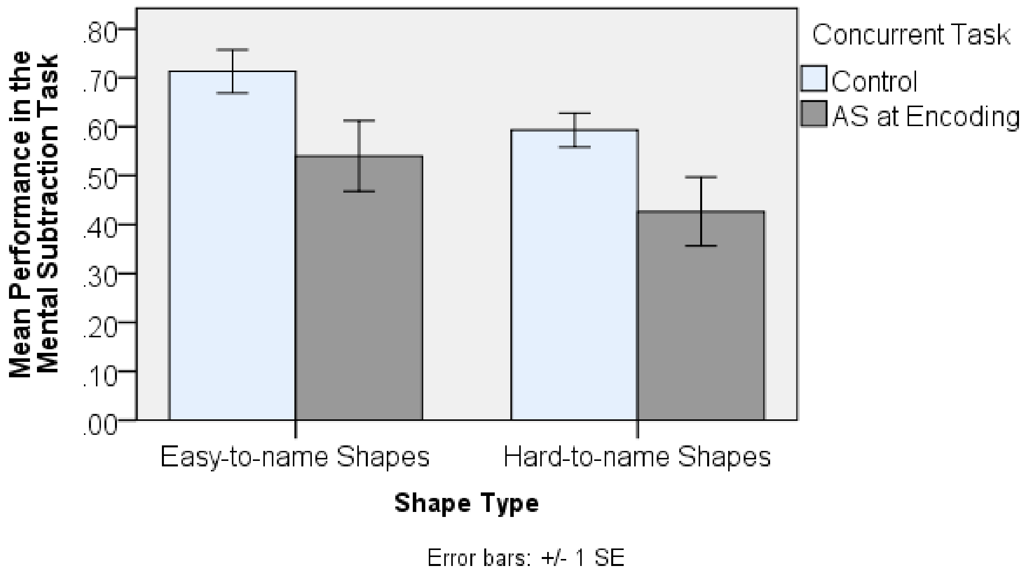


Figure 17. Performance in the subtraction task in Experiment 7, expressed by the proportion correct score for items in each condition.

Discussion

Experiment 7 used a new mental subtraction paradigm and replicated the positive effect of spontaneous naming in the temporal presentation method (Experiments 1 and 2). AS at encoding was found to impair performance compared to the control condition across both easy-to-name and hard-to-name shapes, implying that the verbal code was used for each. This finding was different from that obtained by previous studies using a mental subtraction paradigm. In those studies a negative effect of spontaneous naming in the spatial-temporal presentation method was found, as indicated by improved imagery performance following AS vs. no AS when using easy-to-name shapes (Brandimonte et al., 1992b; Pelizzon et al., 1999). This present finding indicates that the positive role of spontaneous naming in the temporal presentation method is not restricted to the mental rotation paradigm. Spontaneous naming in the temporal presentation method is also beneficial in the mental subtraction paradigm.

Experiment 8

Introduction

Experiment 8 used the mental subtraction task and moved from manipulating implicit naming to manipulating explicit labelling in the temporal presentation method. It aimed to replicate the effects of the experimenter-generated labels and cues shown in the mental rotation paradigm when using temporal presentation (Experiment 5). As in that study, Experiment 8 manipulated experimenter-generated labels (either appropriate labels or nonwords labels) during encoding of easy-to-name shapes. In addition, a control condition was used where no labels were presented and spontaneous naming was assumed to occur. Given the findings from Experiment 5, where experimenter-generated labels were found to impair performance compared to the control condition, a similar impairing effect was expected to occur in Experiment 8. Experiment 5 provided evidence that greater impairment was shown by nonwords followed by appropriate labels compared to the control condition. Therefore, it was expected to find a similar pattern of results in Experiment 8. Experiment 5, also, examined the effect of re-presenting the verbal labels as cues at retrieval. Those findings showed that presenting verbal cues (either appropriate words or nonwords) removed the interference due to explicit labelling and improved performance, and a similar positive effect of cueing was expected to occur in Experiment 8.

There were several possible accounts for the negative effects of explicit labelling. The first account is the shift in emphasis account, which suggests that verbalization shifts emphasis from a featural to a global representation, which is not suitable for retrieving the visual item (Brandimonte & Collina, 2008) or from a veridical to a prototypical representation, which is also not suitable for retrieving the visual item (Lupyan, 2008). The second account is the pair association account, which focuses on the linking between the shapes and their labels. It suggests that exposure to label-picture pairs creates verbal visual associations (Verhaeghen et al., 2006), and that remembering one item from a pair requires remembering the whole pair (Hockley & Bancroft, 2011). Therefore, it suggests that pairing verbal labels with pictures impairs memory of the pictures as words are more susceptible to forgetting (Ally & Budson, 2007; Nelson et al., 1976; Shepard, 1967). The third account is the general detrimental effect account. This account suggests that presenting verbal labels alongside the shapes during encoding increases the number of items to be memorized and, hence, decreases the percentage of items that one can recall (Calfee & Atkinson, 1965; Laughery & Pinkus, 1966; Postman & Phillips, 1965; Phillips et al., 1967; Schifrin, 1970). However, evidence from Chapter 5, which examined the effects of experimenter-generated labelling and cueing, suggests that the paired associate account is the most readily applied. See Chapter 5, page 132 for a more detailed discussion. Hence, this is the account that will be focused upon in this section.

The pair association account predicts that presenting verbal labels alongside the shapes impairs imagery performance compared to the control condition. In addition, nonwords are more likely to be forgotten compared to common words (Greene, 2004; Xu & Malmberg, 2007). Thus memory of shapes associated with nonwords was expected to be lower than memory of shapes associated with common words. Additionally, the beneficial effect of cueing found in Experiment 5 does suggest that verbal-visual associations were successfully created. Therefore, in the present experiment re-presenting the verbal labels as cues at retrieval was expected to remove the impairment due to explicit labelling and may improve performance to the level of the control condition.

The mental rotation paradigm consisted of only six easy-to-name shapes. Increasing the number of shapes might reduce reliance on the visual code and increase emphasis on the verbal code. Therefore, the number of shapes was increased to 10 shapes for each condition in the current experiment. Heavy reliance on the verbal code that decays faster than the visual code (Ally & Budson, 2007; Nelson et al., 1976; Shepard, 1967) might show a larger impairing effect by experimenter-generated labels compared to the control condition. This is because, according to the pair association account, participants in the experimenter-generated labels conditions cannot remember the shapes when they forget the labels. Another reason for using a larger number of shapes was to avoid a ceiling effect. In the mental subtraction paradigm in Experiment 7, the mean proportion correct score for the easy-to-name shapes in the control condition was at .70. Experiment 8 aimed to compare the positive effect of cueing with the control condition. The cues might enhance performance to a high level compared to the control condition. Using six shapes in each condition might conceal the positive effect of cueing. Hence, the number of shapes has been increased.

Additionally, the number of presentations of the shapes was increased in Experiment 8. However, the time of exposure to each shape did not differ from previous experiments in this thesis. Here, each shape was presented five times, three seconds for each. In contrast, in the previous experiments, each shape was presented three times, five seconds for each. It was expected that presenting the label-picture pairs five times as opposed to three times would strengthen the verbal-visual association. This was based on findings from Experiment 6, in Chapter 6, which showed that reduction of exposure to the label-picture pair removed the interfering effect of explicit labels at encoding and may suggest that this was a result of failure to form strong verbal-visual association. Hence, Experiment 6 suggested that repetition is required to strengthen verbal-visual associations. The findings from Experiment 6 were consistent with studies that showed beneficial effects of repetition in learning pairs and suggest that learning pairs is an incremental process (Battig, 1962; Postman, 1962). Strengthening the verbal-visual association, consequently, may show a larger benefit from providing verbal cues at retrieval. It was found, in Experiment 5, that presenting verbal cues had a general positive effect on both appropriate labels and nonwords labels conditions. However, appropriate cues outperformed nonwords cues in Experiment 5. Therefore, it was expected in Experiment 8 that increasing repetition to the label-picture pairs may result in positive significant effects for both appropriate and nonwords cues on performance, and that appropriate cues may still outperform nonwords cues. Moreover, level of performance in appropriate cues and nonwords cues may improve in comparison with performance in the control condition in Experiment 8, as repetition of exposures to the pairs may increase label-picture associations, and thus lead to stronger cueing effects.

Participants

Seventy-five healthy adults (53 females, 22 males), age range 18-39 (mean = 25 years and 4 months) were recruited from the University of Leeds. All participants had normal or correct-to-normal vision, and were native English speakers. No participant had participated in Experiment 7 that used the subtraction paradigm. Participants gave their informed consent prior to the experiment, and were paid a small amount of money in return for their participation. They were assigned to five groups, 15 participants each.

Materials

The stimuli included ten easy-to-name shapes. They were the six easy-to-name shapes used in Experiment 7, in addition to four new easy-to-name shapes. See Figure 18 for the new easy-to-name shapes, the halves that should be removed, and the correct answers. As mentioned in the introduction to Experiment 8 adding additional items between Experiment 7 and Experiment 8 aimed to prevent the high level of performance in the control condition found in Experiment 7. This is because Experiment 8 aimed to compare the positive effect of cueing with the control condition. High level of performance might show the ceiling effect and conceal the differences between the conditions where appropriate cues were used and the control condition. Therefore, larger number of shapes was used in order to increase the percentage of items forgotten (Calfee & Atkinson, 1965; Laughery & Pinkus, 1966; Phillips, Shiffrin & Atkinson, 1967; Postman & Phillips, 1965; Shiffrin, 1970) and avoid the ceiling effect that might conceal the positive effect of cueing.

The agreed names, taken from the preliminary naming agreement test, were used as appropriate labels in this experiment. See Table 6 for the names for each shape and number of participants agreed on the names. Nonwords were generated by nonwords generator software (http://www.maccs.mq.edu.au) (Rastle et al., 2002). Each nonword had one syllable and had no neighbours (words that can be created from Nonwords by changing only one letter). See Table 6 for the nonwords for each shape. The same nonword always appeared with the same shape across all participants. Each of the non-words was five to seven letters long. Nonwords were not matched to the appropriate names in the number of letters as some of the appropriate names were nine-letters long (e. g., butterfly). In contrast, the number of letters in the nonwords was never larger than seven letters. Increasing the number of letters in nonwords might make them difficult to pronounce and this might not allow participants to verbally rehearse the nonwords. Verbal rehearsal is important for encoding verbal items (Baddeley & Hitch, 1974). Therefore, it was aimed to avoid having a large number of letters for nonwords. The number of letter for appropriate labels, in Experiment 8, was always larger than the number of letters for nonwords corresponding to the same shapes. Therefore, if one argued that having larger number of letters in one type of labels was the reason for having lower performance for these labels, then appropriate labels would have lower performance than nonwords. This is because having a larger number of letters increases the possibility of forgetting (Phillips, Shiffrin & Atkinson, 1967; Postman & Phillips, 1965). However, the opposite pattern of results was revealed. Performance for nonwords was lower than performance for appropriate labels. Therefore, the lower performance for nonwords compared to appropriate labels cannot be attributed to the length of the letter string in the nonwords.

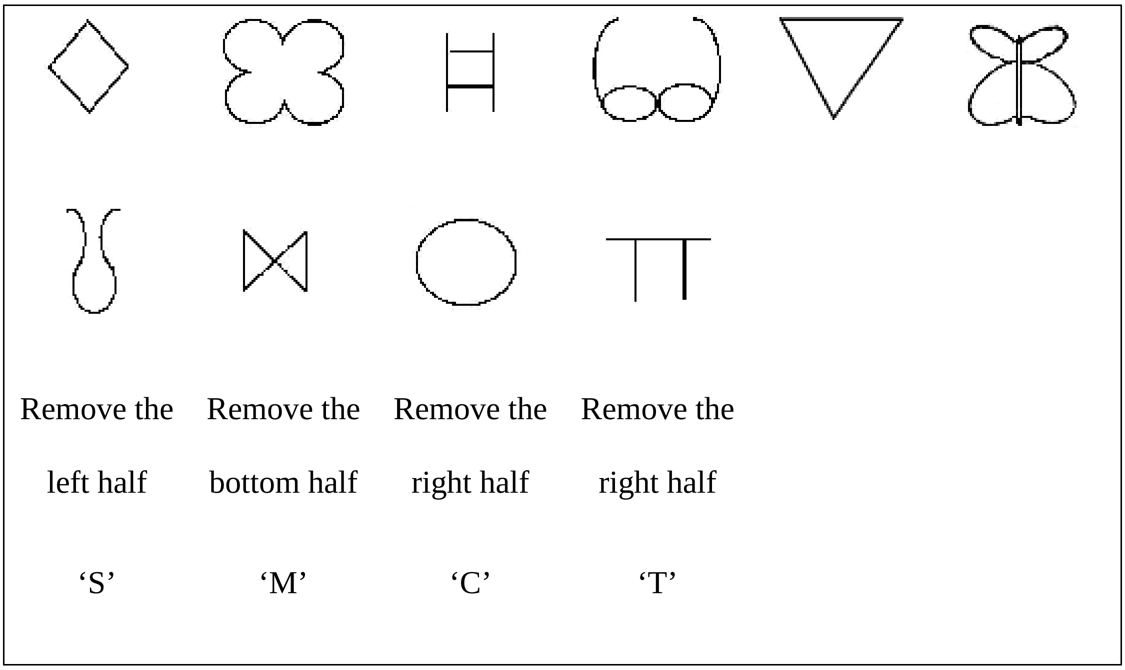


Figure 18. The 10 easy-to-name shapes for the subtraction task in Experiment 8.

The six shapes on the top were also used in Experiment 7, while the four lower shapes were new for this experiment.

Table 6. Names, correct letters/numbers for easy-to-name shapes for the mental subtraction task and % of participants agreed on the names.

Shape	*Correct Answer*	*Name*	*% of Participants Agreed on the Name*	*Nonwords*
1	V	Diamond	86%	Klalns
2	3	Flower	90%	Girmb
3	H	Ladder	90%	Thydes
4	6	Glasses	81%	Biened
5	7	Triangle	76%	Klodge
6	B	Butterfly	95%	Steuz
7	S	Vase	62%	Thaick
8	M	Tie	53%	Wherts
9	C	Ball	66%	Whompse
10	T	Table	53%	Plemn

Design and Procedures

The design was a 2 (label type: appropriate labels vs. nonwords labels) x 2 (cue type: cues vs. no cues) between-subjects factorial design, in addition to the control group. Participants were randomly assigned to one of five groups (control group, appropriate verbal labels at encoding, nonwords labels at encoding, appropriate verbal labels and cues, nonwords labels and cues). The dependent variable was the number of letters/numbers correctly identified in each condition.

Participants were tested individually in a session lasting about 15 minutes. The ten shapes were presented sequentially on a computer screen, at a rate of three seconds for each shape, and a one second interval screen preceded each shape. The shapes were presented as black line-drawings in the middle of a white screen. The presentation was repeated five times, in the same order for all five presentations, and an interval screen was exposed before each presentation, asking participants to press the SpaceBar to view the presentation again. The participants saw each shape for 15 seconds. The order of shapes varied across participants. Participants were asked to memorize the shapes and were not told about the hidden letters/numbers. Participants in the labelling conditions were shown either appropriate labels or nonwords during this encoding phase. The labels were presented in a black font one centimetre below the shapes. No further instruction was given to participants in the labelling conditions regarding labels.

After the learning phase, participants practiced the task. The practice phase was as the same as that of Experiment 7.

Participants then performed the subtraction task with the ten shapes in order. The procedures in each trial were the same as that in Experiment 7. In the cueing conditions, participants were again shown either the appropriate labels or the nonwords that they had previously viewed, on the centre of the screen above the sentence asking them to do the subtraction task.

Possible Confounds by Using Appropriate Labels as Cues. One possible confound in the results for this experiment is that using appropriate labels as cues may give substantial benefit to performance because these labels are already matched with the shapes. A high level of performance in the appropriate cue condition would not then reflect visual memory performance; it would rather reflect already-learned associations. Therefore, fourteen independent participants attempted to perform the same image subtraction task when they are given only the appropriate names of the easy to name stimuli, but not the pictures. If 50% of participants identified the hidden letter/number from their labels, the shapes were excluded from the analysis.

More than 50% of participants generated the answers to four of the easy-to-name stimuli (diamond, ladder, triangle, and ball) just from the labels. In fact, three of these four shapes were used in the mental subtraction paradigm used in Experiment 7. However, that study did not include a cueing condition, and thus being able to carry out the imagery task successfully merely on the basis of the labels was not problematic. For the current experiment however, where cueing conditions were used the analysis was only performed on the six remaining shapes ([1]). However, it is possible that some participants were using already-learned

---

([1]) A similar pattern of effects were observed when including data from all 10 stimuli. However, as the analysis is by-items, effects were stronger due to the increased statistical power these items provide. The results in this chapter show the by-item analyses of the lower statistical power. The analysis with lower statistical power was used as this analysis included the shapes for which correct responses associations to recall the shapes. Therefore, it is still difficult to disentangle visual memory from already-learned associations.

Results

As there was one correct answer for each shape, participants' responses were scored as 0 when they gave an incorrect answer or 1 when they gave a correct answer. Within each condition participants responses were then pooled to provide a mean proportion correct score for each item. See Figure 19 for the mean proportion correct scores for each condition. Analyses by-participants provide a similar pattern of results, and therefore, are reported in Appendix K. However, it will be highlighted when differences between the by-items and by-participants analyses arise. The *F* values for participant analyses, when presented in the chapter, will be labelled as F^2.

It was aimed to examine whether appropriate names would show better imagery performance compared to performance influenced by nonwords. A 2 (label type: appropriate labels vs. nonwords) x 2 (cue type: cues vs. no cues) repeated measures Analysis of Variance (ANOVA) revealed a marginally significant main effect of label type on participants performance in the subtraction task, F (1, 5) = 5.81, p = .06, *MSe* = .013, η^2p= .54. Performance in the appropriate label condition (M = .42, SD = .18) was marginally higher than performance in the nonwords condition (M = .31, SD = .13). The main effect of cueing was significant, F (1, 5) = 37.33, p < .01, *MSe* = .011, η^2p= .88. Performance on cueing conditions (M = .5, SD = .17) was significantly higher than performance on no cueing conditions (M = .23,

---

were thought to be based on visual memory. However, it is highlighted when differences between the analyses emerge.

SD =.15). The effects of label type did not interact with cueing, *F* (1, 5) = .52, *p* = ns.

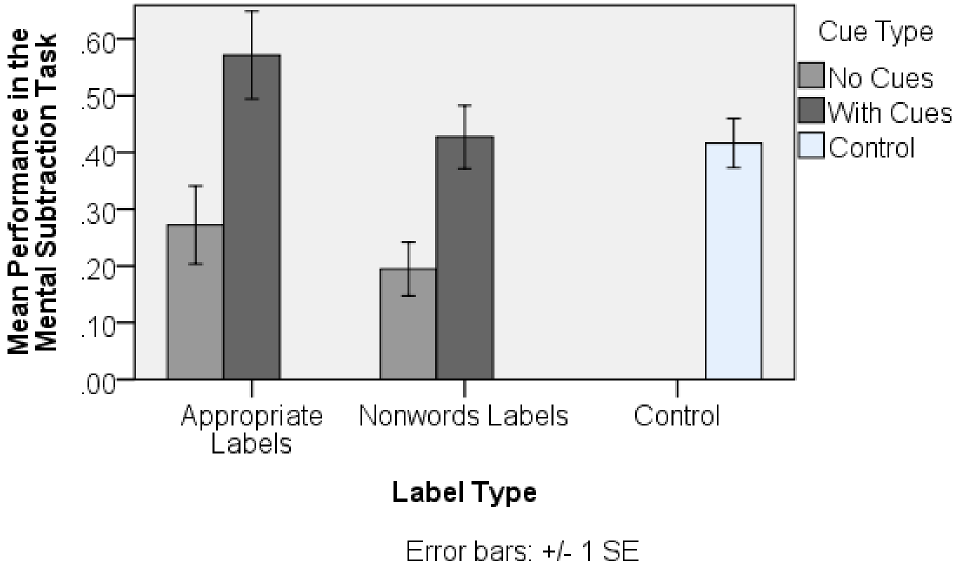


Figure 19. Performance in the subtraction task in Experiment 8, expressed by the proportion correct score for items in each condition.

Additionally, it was aimed to examine the effect of experimenter-generated labels compared to spontaneous naming, which was expected to occur in the control condition. A one way repeated measure ANOVA between the control condition, appropriate labels with no cues and nonwords with no cues revealed a significant effect of label type, *F* (2, 10) = 7.46, *p* < .01, *MSe* = .01, $\eta^2 p$= .6. Post hoc comparisons using the Tukey HSD test indicated that performance for the control condition (*M* = .42, *SD* = .11) was not significantly higher than appropriate labels with no cues condition (*M* = .27, *SD* = .17), *p* = ns. However, the control condition (*M* = .42, *SD* = .11) was significantly higher than nonwords with no cues condition (*M* = .19, *SD* = .12), *p* < .05. Finally, performance for appropriate labels with no cues condition (*M* = .27, *SD* = .17) was not significantly higher than the nonwords with no cues condition (*M* = .19, *SD* = .12), *p* = ns.

Based on the pair association account, it was expected to find a detriment of appropriate labels with no cues compared to the control condition, though not to the same level as nonwords at encoding with no cues. Difference scores were explored by calculating the differences in the means between the control condition and each of appropriate labels with no cues and nonwords with no cues. A one way ANOVA did not show a significant main effect of the label type on the size of differences from the control condition, F (1, 5) = 1.19, p = ns, MSe = .01, $\eta^2 p$= .56. The size of difference from the control condition was not different for appropriate labels with no cues (M = .15, SD = .12) compared to nonwords with no cues (M = - .22, SD = .12).

Furthermore, it was aimed to examine whether presenting labels as retrieval cues improved performance to the level of the control condition. A one way repeated measure ANOVA between the control condition, appropriate cues and nonword cues revealed a significant effect of cue type, F (2, 10) = 4.99, $p < .05$, MSe = .01, $\eta^2 p$= .5 (although, this effect was not significant in the participant-based analyses). Post hoc comparisons using the Tukey HSD test indicated that performance for the control condition (M = .42, SD = .11) was not significantly lower than appropriate labels with cues condition (M = .57, SD = .19), p = ns. Additionally, the control condition (M = .42, SD = .11) was not significantly lower than nonwords with cues condition (M = .43, SD = .17), p = ns. Finally, performance for appropriate labels with cues condition (M = .57, SD = .19) was not significantly higher than nonwords with cues condition (M = .43, SD = .17), p = ns.

Difference scores were explored by calculating the differences in the means between the control condition and each of appropriate labels with cues and nonwords with cues. A one way ANOVA showed a marginally significant main effect of the label type on the size of differences from the control condition, F (1, 5)

= 6.43, p = .05, MSe = .01, η^2p= .56. The size of difference from the control condition was larger for appropriate labels with cues (M = .16, SD = .15) compared to nonwords with cues (M = - .01, SD = .1).

Analyses including all 10 shapes. Analyses including all 10 shapes, at the preliminary analyses of the data, are reported in Appendix K. However, differences between results when running the analyses on six shapes and 10 shapes are reported here. A 2 (label type: appropriate labels vs. nonwords) x 2 (cue type: cues vs. no cues) repeated measures Analysis of Variance (ANOVA) revealed a marginally significant effect of label type when the analyses was ran on only six shapes. However, the main effect of label type was significant when all 10 shapes were included in the analysis, F (1, 9) = 9.97, p < .01, MSe = .02, η^2p= .53.

Additionally, post hoc comparisons, following a main effect of label type on performance in the control, appropriate labels with no cues, and nonwords with no cues, showed no significant difference between the control condition and appropriate labels with no cues when only six shapes were included in the analyses. However, post hoc comparisons using the Tukey HSD test, when all shapes were included, indicated that performance for the control condition (M = .48, SD = .15) was significantly higher than appropriate labels with no cues condition (M = .28, SD = .16), p < .05.

Discussion

Experiment 8 used the mental subtraction paradigm. It aimed to examine whether findings from Experiment 5 (using the mental rotation paradigm) can be generalized to another paradigm and set of shapes. Experiment 8 examined the effect of experimenter-generated labels at encoding compared to the control condition that was assumed to encourage spontaneous naming. It was expected, based on findings from Experiment 5 that experimenter-generated labels would impair performance compared to the control condition. It was also expected that impairing effects of nonwords would be larger than the effects of appropriate labels. In addition, Experiment 8 aimed to explore the effect of verbal cues at retrieval. It was predicted based on the results from Experiment 5 using a mental rotation imagery task, that verbal cues remove the impairing effect of explicit labelling at encoding and improve imagery performance. The findings from Experiment 8 were indeed consistent with these predictions. Presenting experimenter-generated appropriate labels alongside the shapes during encoding impaired imagery performance compared to the control condition. This negative effect of appropriate labels showed a trend, but was not significant, in Experiment 5. Nonwords, in Experiment 8, impaired performance to a larger extent compared to appropriate labels. In addition, the negative effect of experimenter-generated labels was removed by using the verbal labels to cue memory at retrieval. Imagery performance was improved after cueing to the same level as the control condition, and there was a trend to better performance than the control in the appropriate cue condition. These findings from Experiment 8 are discussed below in the light of the pair association account.

The negative effect of experimenter-generated labels is best explained by the pair association account. Presenting the labels alongside the shapes required participants to match the shapes with the labels (Verhaeghen et al., 2006). Creating such associations makes successful retrieval of each item dependent on remembering the whole pair (i.e., if one item from a pair was forgotten, the other item cannot be retrieved) (Hockley & Bancroft, 2011). Therefore, presenting verbal labels with the shapes impaired performance compared to the control condition, which was not presented with verbal labels. Moreover, nonwords are most likely to be forgotten (Greene, 2004; Xu & Malmberg, 2007), and hence, presenting nonwords with the shapes showed more impairment compared to presenting appropriate labels. Furthermore, the appropriate labels in this current experiment showed a significant impairing effect compared to the control condition (when all 10 shapes were included in the analyses) whereas in Experiment 5 they had only shown a trend towards impairment. There were only six shapes in Experiment 5, and hence, participants created six verbal-visual associations. In this current experiment, participants viewed ten shapes and created ten associations during encoding. It has been shown that increasing the number of items in a sequence increases the percentage of items forgotten (Calfee & Atkinson, 1965; Laughery & Pinkus, 1966; Phillips, Shiffrin & Atkinson, 1967; Postman & Phillips, 1965; Shiffrin, 1970). The pair association account is applicable for the results from Experiment 5 and Experiment 8. Appropriate labels might not impair performance compared to spontaneous naming when a small number of shapes were used. When the number of shapes was increased, the number of pairs increased and the likelihood of forgetting items increased (Calfee & Atkinson, 1965; Laughery & Pinkus, 1966; Phillips et al., 1967; Postman & Phillips, 1965; Shiffrin, 1970). This increase of number of items may have led to the greater impairing effects of appropriate labels.

Additionally, verbal cues removed impairment for both appropriate labels and nonwords conditions and improved performance to the level of the control condition. This again supports the pair association account. Cues facilitated access to the visual shapes, and this indicated that verbal-visual associations were initially created (Verhaeghen et al., 2006). Compared to Experiment 5, which used fewer exposures to each label-picture pair, it seems in Experiment 8 that stronger associations may have been created for both appropriate labels and nonwords. For the appropriate labels there is a trend toward higher performance in the cue condition than control condition, and this was not found in Experiment 5, which showed similar level of performance in the appropriate cues condition and the control condition. Furthermore, the level of performance in nonwords with cues (M = .43) in Experiment 8 is at an equivalent mean level to performance in the control condition (M = .42). In comparison, a numerically lower performance was found for nonwords with cues condition (M = .32), in Experiment 5, compared to the control condition (M = .42). Together, these findings may imply that pair association is an incremental process and that increasing the number of exposures to the label-picture pairs strengthens the verbal-visual association (Postman, 1962; Battig, 1962). However, future research could systematically explore whether increasing the number of exposures to label-picture pairs enhances the verbal-visual associations.

In summary, Experiment 8 replicated the impairing effects of experimenter-generated labels on easy-to-name shapes within the temporal presentation method. Additionally, it replicated the benefits of verbal cues at retrieval. These findings suggest that the pair association account is applicable for explaining the negative effect of explicit labelling in the temporal presentation method. In general, findings from Experiment 7 and 8 that used the mental subtraction paradigm again illustrated the differences between covert spontaneous naming and explicit labelling when using temporal presentation.

Chapter 8: General Discussion

The main aim of this thesis was to examine the conditions under which verbal information can interfere with and facilitate visual memory. Visual memory was assessed using two different visual imagery tasks: the mental rotation paradigm in Experiments 1 to 6 and the mental subtraction paradigm in Experiments 7 and 8. In the mental rotation paradigm, participants were asked to memorize a set of shapes and then recall the shapes and, mentally, rotate them to discover two hidden letters in each shape. In the mental subtraction paradigm, participants were, also, asked to memorize a set of shapes and then recall each shape and mentally remove half of it in order to discover a hidden letter or a number. Experiments 1, 2 and 3 examined the effect of covert spontaneous naming on imagery performance. The presence and absence of spontaneous naming was manipulated by the presence or absence of concurrent verbal tasks (AS and the preload task). AS was manipulated at encoding and retrieval and involved repeating the sequence: one, two, three and four, at a rate of two digits per second. Active articulation of digits was expected to suppress verbal recoding and rehearsal (Baddeley & Hitch, 1974; Cocchini et al., 2002; Morey & Cowan, 2004). The preload task was manipulated at retrieval and involved maintaining a sequence of three digits whilst performing the imagery task and then recalling the digits. It was expected that silent rehearsal of the digits would suppress the use of the verbal code (Baddeley & Hitch, 1974; Cocchini et al., 2002; Morey & Cowan, 2004). In particular, these experiments examined how effects of verbal information are mediated by three methods of stimulus presentation: (1) the temporal presentation, (2) the spatial-temporal presentation, and (3) the spatial presentation. (1) The temporal presentation method presented the shapes one-by-one in the same location on the centre of the screen. Each shape was presented multiple times during encoding and the order of presentation of the shapes in this method was the same for all presentations. Additionally, shapes were recalled at retrieval in the same order they had been encoded. Hence, this method emphasized dependence on order information and removed the effects of spatial information. A variant of the temporal presentation method, using paper-based materials, where participants were presented with individual cards shown one at a time, provided similar results. (2) The spatial-temporal presentation method had similar order elements to that of the temporal presentation method but added spatial information. Shapes were presented in the same order for all presentations. They were laid down in a row face down on the table which was visible to the participant for the full duration of the encoding phase. From left to right, one shape at a time was turned face up and shown to the participant. The shapes were also left on the table at retrieval to be used as spatial cues, and they were recalled in the same order they had been encoded. This method, therefore, emphasized dependence on both temporal and spatial cues. This spatial-temporal presentation method only used paper-based materials, similar to what was used by Brandimonte et al. (1992a). (3) The spatial method presented the shapes in different locations on the screen. There were multiple presentations of each shape with no particular order. The main aspect of the spatial presentation method was that blank boxes were presented on the screen in a specific spatial arrangement and each shape was assigned to and appeared within a certain box. The six boxes were left on the screen during encoding and retrieval to be used as spatial cues. Recall of shapes was not in the same order as at encoding, but each shape was cued with the box that it was presented in during encoding. Thus, the emphasis in the method was on the spatial information without temporal information. The temporal presentation method showed novel findings regarding the influence of verbal information on visual memory. (1) Both easy-to-name and hard-to-name shapes can be associated with verbal coding under temporal presentation methods. This contrasted the assumption in the previous literature that only easy-to-name shapes encourage verbal recoding while hard-to-name shapes discourage verbal recoding (Brandimonte et al., 1992a; 1992b). (2) Covert spontaneous verbal coding was found to enhance performance in the mental imagery rotation task. This contrasted the results obtained using the spatial-temporal and spatial presentation methods, where verbal coding did not help imagery performance, as well as previous work in the literature that had reported negative effects of spontaneous verbal coding on imagery performance (Brandimonte et al., 1992a; 1992b; Pelizzon et al., 1999). To fully explore the role of verbal coding under temporal presentation methods, Experiment 4, 5 and 6 made a turning point from examining the effects of covert spontaneous naming to examining the effects of explicit labelling during encoding in the temporal context. Explicit labelling during encoding was first examined using self-generated labels (Experiment 4) Self-generated explicit labels were found to impair performance compared to covert spontaneous naming in the temporal presentation method of both easy-to-name and hard-to-name shapes (Experiment 4). The following experiments (Experiments 5 & 6) examined the conditions under which this detrimental effect of explicit labelling could be reduced or removed. To do this experimenter-generated labels were applied to easy-to-name shapes. The experimenter-generated labels, used in Experiments 5 and 6, were either appropriate labels for the shapes, which were determined via a naming agreement test by Brandimonte et al., (1992a), or nonwords, which were created by a nonword generator software, and therefore not relevant to the visual characteristics of the shape. Each appropriate label and nonword was assigned to the same shape across all conditions, and each nonword had a number of letters that was similar to the number of letters in the corresponding appropriate label. The effects of explicit labels on subsequent imagery performance were also examined under conditions where the explicit labels were either re-presented or not presented as cues during retrieval (Experiment 5). Experiment 6 followed Experiment 5 to examine whether a reduction in the number of exposures to the experimenter-generated labels presented alongside the shapes during encoding would reduce or remove the effect of the verbal labels. Here, labels were presented at one round of presentation whilst shapes were presented for three rounds. By implication, this also reduced the amount of time that the participant was exposed to the label. In this experiment, the time-point at which the labels were presented, either at the first or the last round of presentation was also manipulated. Finally, Experiments 7 and 8 re-examined the effects of spontaneous naming and explicit labelling in the temporal context, using a new mental subtraction paradigm. The key aim of replicating the findings of the thesis using a different mental imagery paradigm was to examine whether these findings extended beyond one particular imagery task.

It should be acknowledged that visual imagery paradigms (the mental rotation and the mental subtraction paradigms) have methodological restrictions that may decrease the statistical power of results. For instance, a limited number of items can be used in each condition. This is because the visual imagery paradigm involves one experimental block (one learning phase followed by one test). Since, there is only one learning phase, it is not possible to include a large number of items to be memorised. The reason for including only one block in the experiment is that presenting the learning phase should precede informing participants about the retrieval task. This is critical for the paradigm as forewarning participants about the test (i.e., the need to identify the constituent letters or parts of the shape) may affect the strategies they adopt to learn the shapes. Given this limitation, the approach primarily taken here is to highlight the key findings in this thesis that were replicated across more than one experiment.

Another issue is the problem of un-replicability. As mentioned in Chapter 1, some studies failed to replicate the verbal interference effect (e.g., Lyle & Johnson, 2004; Memon & Bartlett, 2002). Additionally, this thesis failed to replicate the negative effect of spontaneous naming on the spatial-temporal method (Experiment 1) and spatial method (Experiment 3) found in previous studies (Brandimonte et al., 1992a; 1992b; Pelizzon et al., 1999). Schooler (2012) suggests that when a large number of studies try to replicate an effect, the likelihood of finding significant results decreases. This is because the first study has a large chance of finding a false positive effect (type I error). The conventional level of alpha value is .05. Therefore, the first study to show a positive effect has a chance of getting a false positive result at 5%. In contrast, subsequent studies, which try to replicate the original effect, are less likely to find a similar false positive effect (the probability of error becomes less than 5%). However, as not all results are made publically available, this assumption is difficult to be examined (Schooler, 2011). Most of the times, experiments are not reported or published unless the results are significant. This creates another problem. When only significant results are published, alpha value at .05 becomes incorrect. The percentage of false positive becomes larger than 5% because many null results were not made publically available (Francis, 2012; Makel, Plucker & Hegarty, 2012; Pashler & Harris, 2012). Hence, a positive effect might be shown in several studies although it is an unreal effect. Schooler suggests a solution for this issue by making a depository for all unpublished experiments (Schooler, 2011). Additionally, Simmons, Nelson and Simonsohn (2011) suggest that researchers should report all examined variables to reduce the problem of un-reliability and, in turn, the rate of false positive results. This indicates that transparency in methodology and analyses helps to reduce the probability of false positive and may solve the problem of un-replicability.

Moreover, most of the studies that tried to replicate an effect did not aim to make an exact replication of previous studies. They rather tried to replicate the findings using different parameters from the original experiments. Such indirect replications can show that findings from one study can be generalized to other situations (Makel et al., 2012; Pashler & Harris (2012). The experiments in this thesis mainly aimed to examine the effects of task demands on the role of the verbal code in visual memory. Therefore, it was expected that the findings under several conditions would differ from findings in previous studies. For example, AS at encoding impaired memory performance in the temporal presentation method in Experiment 1 and 2. This indicates that spontaneous naming enhances performance in the temporal presentation method. In contrast, previous studies (e.g., Brandimonte et al., 1992a; 1992b) showed that AS at encoding improved performance in the spatial-temporal presentation method, and this indicates the negative effect of spontaneous naming in the spatial-temporal presentation method.

Additionally, this thesis used separate item-based analyses, where data are collapsed over items (i. e., the shapes), and participant-based analyses, where data are collapsed over participants. Some researchers criticized the method of separate use of item-based and participant-based analyses (Clark, 1973; Raaijmakers, 2003; Raaijmakers, Schrijnemakers & Gremmen, 1999). They argued that this procedure might increase type I error, where an unreal effect is found to be significant. This might be true when the items are random samples from the population (e.g., using a random set of words for each condition). This is because using a random sample of items increases the variation for each condition in the experiment and, hence, *F* value might not give an accurate estimate of the effects. In this case, a very conservative procedure, called min *F*, may be used to examine whether the experimental manipulation is reliable over both participants and items. Min *F* is a value that has a corrected degree of freedom (see Clark, 1973 for more details). Alternatively, matching the sample of items in all experimental conditions makes the use of a separate *F* value reliable (Raaijmakers et al., 1999). In this thesis, attempts have been made to match items across conditions. For example, attempts have been made to match easy-to-name and hard-to-name shapes that were used in the mental rotation and mental subtraction. Therefore, Min *F* was not used in this thesis. This is because Min *F* is very conservative and might conceal real effects. Instead, item-based analyses were used in the main text. The *F* values for item-based analyses were most of the time consistent with *F* values for participant-based analyses. However, it was highlighted in the main text when different levels of significance were obtained for each of item-based and participant-based analyses. As mentioned above, attempts were made to match the items in each condition. However, it is still not sure that the items were exactly matched together. Therefore, it was aimed to replicate findings by different experiments when, for instance, the results were significant by-items but were not significant by-participants.

A summary of the experiments undertaken for this thesis and their findings are presented in Appendix L. The key findings from the thesis are summarized in the next section. The following sections draw on the overall findings for the role of verbal coding in visual imagery and the theoretical and methodological contributions of this thesis.

Summary of Findings

From the series of experiments in this thesis, the following patterns of findings can be drawn out:

(1) When using the temporal presentation method, engaging in AS at encoding impaired imagery performance for both easy-to-name shapes (Experiments 1, 2 and 7) and hard-to-name shapes (Experiments 2 and 7). It is assumed that AS disrupted verbal recoding and rehearsal (Baddeley & Hitch, 1974; Cocchini et al., 2002; Morey & Cowan, 2004). Therefore, these findings indicate a positive effect of verbal information during encoding on visual memory.

(2) When using the spatial-temporal and spatial presentation methods, AS at encoding was not shown to affect the level of imagery performance for easy-to-name shapes (Experiments 1 and 3); imagery performance was at the same level with and without AS.

(3) When using the temporal presentation method, engaging in AS or the preload task at retrieval, both tasks known to disrupt verbal recoding and rehearsal (Baddeley & Hitch, 1974; Cocchini et al., 2002; Morey & Cowan, 2004), impaired imagery performance for both easy-to-name and hard-to-name shapes (Experiment 2). These findings imply a positive effect of verbal information during retrieval on visual memory.

(4) When using spatial presentation, engaging in the preload task at retrieval did not affect the level of imagery performance for easy-to-name shapes (Experiment 3); imagery performance was at the same level with and without the preload task.

(5) When using the temporal presentation method, producing self-generated labels at encoding for easy-to-name and hard-to-name shapes impaired performance compared to a no-labelling (control) condition (Experiment 4).

(6) When using the temporal presentation method, viewing experimenter-generated labels at encoding for easy-to-name shapes impaired performance compared to a no-labelling (control) condition; both experimenter-generated appropriate labels that match the shapes and experimenter-generated nonwords impaired performance. However, nonwords compared to appropriate labels showed larger impairing effects (Experiments 5 & 8).

(7) When using the temporal presentation method, for easy-to-name shapes, re-presenting the verbal labels as cues at retrieval can remove the impairing effects of presenting experimenter-generated appropriate labels and experimenter-generated nonwords at encoding (Experiment 5 & 8).

(8) When using in the temporal presentation method, reducing the number and, by implication, the time of exposures to experimenter-generated labels during encoding may be, tentatively, expected to remove the impairing effects of experimenter-generated labels (Experiment 6). In contrast, increasing the number of exposures to the labels may be, tentatively, expected to strengthen their impairing effects (Experiment 8). However, replications of these findings are needed before firm conclusions can be drawn.

How Do Task Demands Affect Verbalization in Visual Imagery?

As mentioned in Chapter 1, effects of verbal interference and verbal facilitation can occur within the same visual imagery paradigm (e.g., Brandimonte & Collina, 2008). Brandimonte and Collina showed that presenting experimenter-generated labels after encoding hard-to-name shapes impaired imagery performance.

Nevertheless, they showed that re-presenting verbal labels that correspond to features of the shapes as cues at retrieval improved performance. This demonstrates the role of task demands in showing or reversing the verbal interference effect (Brandimonte et al., 1992a; Brandimonte et al., 1992b; Brandimonte et al., 1997; Brandimonte & Collina, 2008; Hitch et al., 1995; Pelizzon et al., 1999; Pelizzon et al., 2002). This thesis looked at the influence of several task demands: the nature of the presentation method, the nature of the label (spontaneous covert or explicit labelling) and the match between label and shape.

Presentation method. One of the key task demands in visual imagery is the presentation method. Previous findings from the spatial-temporal presentation method, where the shapes were presented in the same temporal order and were laid down in a row so that each shape had a different spatial location, indicated that covert spontaneous verbal encoding caused verbal interference on imagery performance. AS at encoding was found to improve performance for easy-to-name shapes, compared to a ‘no AS’ control condition. In contrast, spontaneous naming was not assumed to occur for hard-to-name shapes in the spatial-temporal presentation method. Performance for hard-to-name shapes was at a high level with and without AS at encoding (Brandimonte et al., 1992a; Brandimonte et al., 1992b). These findings indicate that when the spatial-temporal presentation method is used covert spontaneous naming shows an impairing effect on imagery performance. Additionally, Pelizzon et al. (2002) showed a similar pattern of findings for easy-to-name shapes in the spatial-temporal presentation method, where both spatial and temporal information was available, and in a spatial presentation method, where only spatial information was available. Therefore, findings from previous studies predict an impairing effect on easy-to-name shapes of spontaneous naming in the spatial-temporal and spatial presentation methods.

Findings from this thesis also indicate that covert spontaneous naming does not seem to be useful for mental imagery tasks. In fact, the findings here suggest that covert spontaneous naming does not necessarily impair imagery performance, for easy-to-name shapes in the spatial-temporal and the spatial presentation method. Performance was at the same level with and without AS in the spatial-temporal (Experiment 1) and spatial presentation method (Experiment 3). It is difficult to argue from a null result, and the difference between findings from previous studies and this thesis may be due to the use of different strategies by participants when learning the shapes. In the present experiments participants reported using other strategies, rather than naming, to learn the shapes, such as making up a story from the sequence and linking the shapes together by similar features. However, taken together these findings suggest that when emphasis is placed upon spatial information, verbal recoding does not seem to be useful, or as evidenced by Brandimonte's et al. (1992a) may even lead to an impairment of performance (see also Brandimonte et al., 1992b; Brandimonte et al., 1997; Pelizzon et al., 2002, for examples).

The temporal presentation method introduced in this thesis, that involves providing order information, without accompanying spatial cues, in contrast, did not show an interfering effect of covert spontaneous naming. The temporal presentation method showed a positive effect of covert spontaneous naming for both easy-to-name and hard-to-name shapes. Previously, findings from Pelizzon et al. (2002) have provided preliminary and indirect evidence that use of the temporal presentation method was not associated with an interfering effect of covert spontaneous naming. They found easy-to-name shapes, in the spatial-temporal and spatial presentation methods benefited from colour cues at retrieval implying that the colour cues overcame the interfering effects of covert spontaneous naming. In contrast, easy-to-name shapes in a temporal presentation method showed a similar high level of performance with and without colour cues. Findings from this thesis have shown directly for the first time that the nature of the presentation method mediates the negative vs. positive effect of spontaneous naming.

Additionally, this thesis used concurrent verbal tasks at retrieval to remove the effect of verbalization. It examined the effect of concurrent verbal tasks at retrieval to show whether absence of verbal information at retrieval can reverse the effects of covert spontaneous naming. Easy-to-name and hard-to-name shapes in the temporal presentation method, which benefit from covert spontaneous naming at encoding, were negatively affected by engaging in concurrent verbal tasks at retrieval (AS and preload) (Experiment 2). This indicates that once the verbal code is used at encoding it should be used again at retrieval.

In contrast, in the current thesis, easy-to-name shapes in the spatial presentation method, which were not affected by spontaneous naming during encoding, were also not affected by the concurrent task (preload) at retrieval (Experiment 3). Previous research similarly indicates that in conditions where spontaneous naming at encoding has been found to impair performance, use of the verbal code at retrieval may also not be important for the task. A study by Brandimonte and Gerbino (1993) examined the effect of AS at retrieval in a mental reversal paradigm. This paradigm used reversible pictures that have two interpretations, such as the duck-rabbit picture. The mental reversal task involved memorizing a picture then mentally viewing the picture and being asked to discover the other interpretation. Brandimonte and Gerbino showed a positive effect of AS at encoding compared to a ‘no AS’ (control) condition, suggesting a negative effect of spontaneous naming. In contrast, they showed no effects of AS at retrieval compared to the control condition, where it was assumed verbal information was accessible at retrieval. This demonstrated that AS at retrieval, which was assumed to block rehearsal (Baddeley & Hitch, 1974; Cocchini et al., 2002; Morey & Cowan, 2004), did not remove the negative effect of spontaneous naming. Hence, AS at retrieval may not be expected to remove the interfering effect via spontaneous naming during encoding.

Covert spontaneous labelling vs. explicit labelling. Findings from the spatial-temporal presentation method (Brandimonte et al., 1992a) showed, also, that explicit labelling had impairing effects similar to covert spontaneous naming. Performance for easy-to-name shapes, which were assumed to be verbally encoded, was at the same low level with and without explicit labels (Brandimonte et al., 1992a). In contrast, hard-to-name shapes are assumed not to elicit covert spontaneous verbal encoding under the spatial-temporal presentation method, and so performance is high, unless participants are forced to verbally code these stimuli. In line with this, presenting explicit labels alongside hard-to-name shapes was found to show an interfering effect similar to the interfering effect via spontaneous naming of easy-to-name shapes. Explicit verbal labels were found to impair performance for hard-to-name shapes compared to hard-to-name shapes with no labels and were found to drop performance for hard-to-name shapes to the level of performance for easy-to-name shapes. Overall, covert spontaneous naming and explicit labelling seem to have a similar effect on visual memory in the spatial-temporal presentation method (Brandimonte et al., 1992a).

In contrast, to the spatial-temporal presentation method, the temporal presentation method in this thesis showed differential effects for covert spontaneous naming and explicit labelling. Covert spontaneous naming helped performance for easy-to-name shapes (Experiments 1, 2 and 7) in the temporal presentation method and, also, helped performance for hard-to-name shapes (Experiments 2 and 7). Explicit labelling during encoding in the temporal presentation method, in contrast, impaired performance for easy-to-name shapes (Experiments 4, 5 and 8) and for hard-to-name shapes (Experiment 4).

One comment is that easy-to-name and hard-to-name shapes are two different sets of stimuli, and they differ in complexity, familiarity, concreteness and imagineability. Hence, one might argue that the comparison between two different sets of stimuli is not legitimate. This might be true, but the stimuli were created so as to have equivalent level of complexity (they have the same number of curved and straight lines) (Brandimonte et al., 1992a). In addition, comparison between easy-to-name and hard-to-name shapes does not aim to highlight the basic differences between levels of performance on each set of shapes. In fact, it was found that when using the temporal presentation method, overall imagery performance for easy-to-name shapes was sometimes more accurate than performance for hard-to-name shapes (Experiments 1, 2 and 7). However, this difference was not always observed (Experiment 4). Thus, the comparison did not take place between the shapes as much as it was used to find an interaction between shape type and other manipulations (e.g., AS or explicit labels) (Brandimonte et al., 1992a). When the spatial-temporal presentation method was used, covert spontaneous naming was assumed to occur for easy-to-name but not for hard-to-name shapes (Brandimonte et al., 1992a; 1992b). Because of this, explicit verbal labels impaired hard-to-name shapes but did not affect easy-to-name shapes, which were already impaired via spontaneous naming (Brandimonte et al., 1992a). In contrast, when the temporal presentation method was used, the fact that AS during encoding impaired performance for both easy-to-name and hard-to-name shapes implies that this particular presentation format encourages covert spontaneous naming to occur for both easy-to-name and hard-to-name shapes (Experiments 1, 2 and 7). All in all, presenting explicit verbal labels, compared to spontaneous naming, during encoding showed interfering effects on imagery performance for both easy-to-name and hard-to-name shapes (Experiment 4). This indicates that covert spontaneous naming and explicit labelling exert separate effects on visual memory under the temporal presentation method.

The match between label and shape. The effect of match between explicit verbal labels and shapes was also explored in this thesis (Experiments 5 and 8) for easy-to-name shapes. Appropriate labels that match the shapes, according to a naming agreement test, showed smaller impairing effect compared to nonwords, which do not match the shapes. This effect was not examined on hard-to-name shapes, but it is also expected that labels that match compared to labels that do not match the hard-to-name shapes would show less impairment on imagery performance. This is because easy-to-name and hard-to-name shapes were almost similarly affected by covert spontaneous verbal coding in the temporal presentation method. In general, the experiments within this thesis show that the match between the labels and the shapes does mediate the impairing effect via explicit labels during encoding in the temporal presentation method, but this effect is yet to be examined in the spatial-temporal presentation method.

Previous findings in the spatial-temporal presentation method showed that re-presenting verbal labels as cues at retrieval can reverse the impairing effect of explicit labelling on hard-to-name shapes. Importantly, performance was improved only when the verbal cues corresponded to features integral to the shapes (that is, according to independent judges who rated the match between the shapes and the labels; Brandimonte & Collina, 2008). Brandimonte and Collina showed that the effect of verbal cues that correspond to features of the shapes was equivalent to the effect of colour cues, which were also found to reverse the interfering effect via explicit labels (Brandimonte et al., 1997). Therefore, they propose that the positive effect of verbal labels, corresponding to visual features, was only because these labels can access information about the features of the shapes. In contrast, verbal cues that do not correspond to features of the shapes did not remove the impairing effects of explicit labels (Brandimonte & Collina, 2008). Re-presenting verbal labels for easy-to-name shapes as retrieval cues, when the spatial-temporal presentation method is used, may give rise to different results compared to those observed with hard-to-name shapes. This may be the case: (1) because explicit labelling, compared to covert spontaneous naming, did not seem to have a further detrimental effect on easy-to-name shapes (Brandimonte et al., 1992a), and (2) the labels generated to easy-to-name shapes may focus on the whole shapes, rather than their features (Brandimonte & Collina, 2008). Hence, using explicit labels as retrieval cues would not be able to trigger the featural representation of the shapes and would not remove the interfering effect. This is a question for future research to address. Findings from this thesis in contrast, demonstrated a positive effect of re-presenting verbal labels for easy-to-name shapes as cues at retrieval, even when they did not match the shapes. Re-presenting appropriate labels and non-words as cues at retrieval reversed the impairing effect of explicit labels during encoding (Experiments 5 and 8).

Summary. Together, findings from this thesis, conjointly, with findings from previous visual imagery studies identified task demands that mediate verbal interference and verbal facilitation in visual memory:

(1) Temporal information mediates the positive role of covert spontaneous verbal encoding in visual memory whilst spatial information mediates the negative role of covert spontaneous verbal encoding in visual memory.

(2) Verbal encoding while temporal information is emphasized, mediates the positive role of verbal information at retrieval whereas verbal encoding while spatial information is emphasized does not show an important role for verbal information at retrieval.

(3) Temporal information mediates a positive role for spontaneous naming and a negative role of explicit labelling during encoding. In comparison, spatial information mediates a negative effect of both spontaneous naming and explicit labelling during encoding of visual memory

(4) Temporal information mediates the positive effect of verbal cues at retrieval after verbal labelling during encoding

(5) Temporal information makes the match between the shapes and the verbal labels during encoding an important mediator for the verbal interference effect.

The Role of Spatial, Spatial-temporal and Temporal Presentation Methods in Visual Memory

Findings from this thesis showed an important role for the spatial, spatial-temporal and temporal presentation methods in mediating the effects of concurrent verbal tasks (AS at encoding in Experiments 1, 2 and 3 and preload at retrieval in Experiments 2 and 3). In the temporal presentation method, concurrent verbal tasks at encoding (Experiments 1 and 2) and at retrieval (Experiment 2) impaired imagery performance. This might suggest that visual items are not temporally coded in long-term visual memory and that the verbal code is required to access the temporal coding of visual items. This is the case only when spatial information is not available. In the spatial and spatial-temporal presentation methods, in contrast, concurrent verbal tasks did not impair imagery performance (Experiments 1 and 3). This might be because spatial coding of visual items may be spontaneously encoded in long-term visual memory. These findings may imply that spatial and temporal coding both affect performance in long-term visual memory.

Upon this, a question may be raised in relation to how spatial and temporal coding operates in memory. Many studies focused on the role of temporal coding of memory of verbal items. They found that error can occur in memory of the order of items although memory of the items themselves is intact (Healy, 1974; Pickering, Gathercole & Peaker, 1998). Therefore, current models in memory of serial order are consistent on the idea that items and orders are encoded in separate, but related sequences. These models suggest that temporal coding operates by attaching items to temporal signals to represent order (Brown, Neath & Chater, 2007; Brown, Preece & Hulme, 2000; Burgess & Hitch, 1999; Lee & Estes, 1981; Page & Norris, 1998). This separation of item sequence and order sequence is ubiquitous in long-term verbal memory as well as immediate verbal memory (Brown et al., 2007).

In memory of temporal order, studies showed that memory of the first and the last items is superior to memory of other items in the sequence, showing what was called a bow shaped curve of memory. Moreover, participants were more likely to confuse items in adjacent positions (i.e., participants were more likely to confuse the third with the fourth item in the sequence but were less likely to confuse the third with the sixth item) (Pickering et al., 1998). Additionally, increasing the time between encoding and retrieval was found to reduce memory of temporal order (Naveh-Benjamin, 1987). Similar findings were shown for memory of spatial positions (Nairne & Dutta, 1992). Nairne and Dutta examined memory of spatial position by asking participants to memorize a sequence of words presented sequentially in an array and then to re-construct the spatial position of the words by writing them in their spatial positions. A bow-shaped curve of memory was found, whereby words on the extreme left and the extreme right of the array showed higher average of correct recall compared to other words in the array. In addition, order of words that were presented in adjacent spatial positions was more likely to be confused with each other. These findings were similar to those found when participants were asked to re-construct the temporal order. Hence, findings from studies of verbal memory indicate that both temporal and spatial coding exists in both immediate and long-term verbal memory.

Additionally, models that explain the relationship between temporal coding and immediate verbal memory can be applied to studies of immediate visual memory. This is because findings from several studies imply that verbal and visual memories are based in parallel systems in short-term memory that share common mechanisms (Anderson, 1976; Avons, 1998; Baddeley & Hitch, 1974; Depoorter & Vandierendonck, 2009); Healy, 1982; Jones, Farrand, Stuart & Morris, 1995; Pickering et al., 1998; Smyth, Hay, Hitch,& Horton, 2005;Smyth & Scholey, 1996). In fact, studies of immediate visual memory showed that visual stimuli can be coded temporally. Poirier et al. (2007) showed that the effects of visual similarity, which is known to impair short-term visual memory, impaired immediate memory of order. They showed that memory of order of visual objects and matrices that are visually similar compared to memory of order of visually de-similar items were impaired. This demonstrates that visual stimuli can be coded temporally (see also Avons, 1998; Healy, 1997; Logie, Della-Sala, Wynn & Baddeley, 2000). This temporal order was also found for visual stimuli that are very difficult to describe such, as schematic faces (Poirier et al., 2007; Smyth et al., 2005). All these findings suggest that visual items can be temporally coded in immediate memory. However, there is no existing evidence to suggest similar temporal coding mechanisms in long-term visual memory.

In relation to this, findings from this thesis demonstrated different levels of performance under the AS effects in the spatial and temporal presentation conditions. It might be the case that temporal coding of visual items is not spontaneously transferred from immediate to long-term visual memory, and that verbal coding is required to access temporal coding of visual items in long-term memory. However, experiments in this thesis did not examine serial recall, but they only emphasized temporal serial order. These methods cannot directly examine whether spatial or temporal coding is used in a certain condition. Therefore, future research may use the re-construction of ordering test to examine the persistence of spatial and temporal coding in long-term visual memory. This may be achieved in the visual imagery paradigm by presenting the answers for the imagery task (letters or numbers) at retrieval and asking participants to assign each answer to the position of its corresponding shape. If lower rates of errors are made for the first and the last item in the sequence, this would indicate that the temporal coding was used. Similarly, if confusion occurred at higher rates between shapes that are adjacent in time-points, this would, also, indicate that temporal coding was used (Nairne & Dutta, 1992). In contrast, if lower rates of errors are made for items in the extreme right and extreme left of the array, this would indicate that the spatial coding was used. Similarly, if larger confusion occurred for shapes that are adjacent in their spatial positions, this would, also, indicate that the spatial coding was used (Nairne & Dutta, 1992). It is expected that performance in the spatial and the spatial-temporal presentation method would use the spatial coding and, hence, would show confusion between shapes that are viewed in adjacent locations. In contrast, performance in the temporal presentation method would be able to access the temporal coding only in the absence of concurrent verbal tasks. Thus the first and the last shapes in the sequence would be better recalled compared to other shapes in the sequence in the conditions where no concurrent verbal tasks were used. In addition, confusion would be high between shapes that are presented in close time-points. Using concurrent tasks, however, with the temporal presentation method would overall dampen performance and would not show the bow-shaped curve and the confusion between adjacent shapes.

Concurrent tasks are known to disrupt verbal recoding of items and verbal rehearsal (Baddeley & Hitch, 1974; Cocchini et al., 2002; Morey & Cowan, 2004). Findings from the mental rotation paradigm (Experiments 1 and 2) and the mental subtraction paradigm (Experiment 7) showed negative effects of concurrent verbal tasks in the temporal presentation method, suggesting an important role for verbal coding. However, one might argue that the negative effects of concurrent tasks found in the temporal presentation method (Experiments 1, 2 and 7) emerged because the concurrent tasks interfered with timing signals that were attached to the shapes. These signals represent the temporal order of the shapes (Brown et al., 2007; Brown et al., 2000; Burgess & Hitch, 1999). This may be the case only when the concurrent verbal tasks involve timing signals that are similar to the timing signals that are used for temporal coding of the stimuli. For instance, it was shown that immediate memory of serial order for both verbal and visual items was impaired by concurrent tasks that included temporal elements, such as irrelevant speech (either words or phonemes in the background which participants were asked to ignore; Henson, Hartley, Burgess, Hitch & Flude. 2003). Additionally, similar impairing effects on immediate memory of serial order of verbal and visual items was found by concurrent tasks that involve continuous change in state (e.g., AS by counting and sequential finger tapping) (Henson et al.. 2003; Jones et al., 1995). In contrast, concurrent tasks that did not involve continuous changing in their states such as AS via repeating one word or syllable did not impair memory of serial order (Jones et al., 1995). Furthermore, interpolated secondary preload tasks that involved serial recall of verbal items (letters) or visual items (lines) impaired performance on the primary task that involved immediate memory of serial order (Depoorter & Vandierendonck, 2009). Moreover, neuropsychological studies showed that memory of order of verbal items and sequential movement were located in the same functional brain areas (pre-motor cortex and the supplementary motor area). Damage to these functional brain areas impaired the ability to produce a repetitive sequential movement by hands and, also, negatively affected the ability to recall sequences in a digit recall task (Halsband, Ito, Tanji & Freund, 1993). This indicates that any task that requires the use of timing signals activates the pre-motor cortex and the supplementary motor area (see also (Catalan, Honda, Weeks, Cohen & Hallett, 1998). These studies, together, suggest that serial order in short-term memory is based on time signals. Therefore, any concurrent task that uses similar time signals can impair memory of serial order. This idea is consistent with the models of memory of serial order which show that temporal order is based on timing signals and that close timing signals compared to distant timing signals are more likely to interfere (Burgess & Hitch 1999; Brown et al., 2000).Thus, concurrent tasks that involve timing signals might interfere with serial order in immediate memory because they are involving the same timing signals.

However, the impairing effect of concurrent tasks on timing signals may be limited to short-term memory. One reason for the absence of this effect in long term memory is that the time scale for the primary task differs from the one of the secondary task. For instance, the rate of presenting the shapes during the learning phase in Experiments 1, 2, 3, and 7 was five seconds each whilst AS at encoding was carried out at a rate of two digits per second. In this case, the two tasks did not use similar time signals. Based on the models of memory of serial order, the interference is likely to occur by competing on similar timing signals (Brown et al., 2000; Burgess & Hitch, 1999). If different timing signals are involved, then the concurrent task is less likely to impair memory of the order of the primary tasks via interfering with timing signals. Another important point is that temporal coding for visual stimuli in long-term memory does not seem to occur, and the verbal coding, therefore, is involved to attach the shapes to their timing signals. Hence, concurrent verbal tasks may impair verbal coding which is important for successful imagery performance in the temporal presentation method. Additionally, the idea of an impairing effect on timing signals via concurrent tasks cannot explain the negative effect of AS at encoding, which used the syllable ‘la’, in Experiment 2, Chapter 3. AS in this condition did not consist of temporal elements, which require timing signals (Jones et al., 1995). Therefore, AS in this condition interfered with verbal recoding and rehearsal and impaired imagery performance (Morey & Cowan, 2004; Cocchini et al., 2002; Baddeley & Hitch, 1974). In addition, the findings from this thesis showed that spontaneous naming showed higher imagery performance compared to explicit labelling in the temporal presentation method (Experiments 4, 5, 6 and 8). They also showed a positive role of verbal cues at retrieval in removing verbal interference via explicit labels (Experiments 5 and 8). These findings suggest that verbal coding is an important moderator for imagery performance in the temporal presentation method. Therefore, the impairing effects of concurrent verbal tasks are not likely to be a result of impairing the timing signals; the impairing effects of concurrent verbal tasks are related to suppressing verbal recoding and rehearsal of visual shapes.

Theoretical Advancement

The main accounts for verbal interference and verbal facilitation in visual memory are related to either the role of processing or the role of representations. The role of processing was mainly used in the literature to explain the verbal interference effect. The processing shift account explains the verbal interference effect in memory by an inappropriate processing shift by verbalization from processing that suits the task to processing that impairs performance in the task. Since visual imagery requires featural processing (Kosslyn, 1980), the processing shift account would suggest that verbal labels shift the processing of the shapes from featural processing of visual details to global processing of the spatial layouts of the shapes. This global processing does not suit the imagery task and, therefore, it would impair performance.

The main assumption of the processing shift account is that verbalization of the last item in a series creates an inappropriate processing shift which continues until the retrieval stage and, thereby, impairs memory for all items in the series (Brown & Lloyd-Jones, 2002; Brown & Lloyd-Jones, 2003; Weston, Perfect & Schooler, 2008). Although this account explains many findings in the broad literature of verbal interference in visual memory (e.g., Schooler & Engstler-Schooler, 1990; Fallshore & Schooler, 1995; Dodson et al., 1997; Brown & Lloyd-Jones, 2002; Brown & Lloyd-Jones, 2003; Nakabayashi & Burton, 2008; Nakabayashi et al., 2011), it cannot explain findings from the visual imagery domain. This is because the processing shift account suggests that verbal interference occurs without having to create a new representation for each stimulus. For this reason, it cannot explain the correlation found between the quality of verbal labels and imagery performance (Brandimonte & Collina, 2008). Moreover, verbal interference was shown in visual imagery when verbal processing was allowed to occur at both encoding and retrieval in the spatial-temporal presentation method (Brandimonte et al., 1992a; 1992b; Pelizzon et al., 1999). For example, using easy-to-name shapes, which encourage spontaneous naming, impaired imagery performance when verbal information was used during both encoding and retrieval. In contrast, AS at encoding, which suppresses the use of verbal recoding and rehearsal (Morey & Cowan, 2004; Cocchini et al., 2002; Baddeley & Hitch, 1974), improved performance for easy-to-name shapes although it created a mismatch between processing at encoding (where verbal coding was suppressed) and retrieval (if it is assumed that easy-to-name shapes are covertly spontaneously named; Brandimonte et al., 1992a; 1992b; Pelizzon et al., 1999). This is evidence against the processing shift account in visual imagery because the processing shift account indicates that a match in processing at encoding and at retrieval should help performance. However, allowing verbal processing to occur at both encoding and retrieval was found to help imagery performance in the temporal presentation method in this thesis (Experiments 1, 2, 5, 7 and 8). Nevertheless, findings from Experiments 5 and 8 showed that the match between the stimuli and the verbal labels mediated imagery performance. The processing shift account cannot explain the role of the match between verbal labels and visual stimuli in mediating the interfering effect, and so cannot fully capture findings in the visual imagery domain.

An important set of accounts for verbal interference effects in visual imagery is the shift in emphasis accounts (Brandimonte & Collina, 2008). A shift in emphasis may relate to one from featural to global images, based on the visual imagery domain, (Brandimonte & Collina, 2008) or from veridical to prototypical images, based on the visual recognition domain, (Lupyan, 2008). This set of accounts implies that the match between the label and the shape determines the interfering effects of explicit labels during encoding. Lupyan suggests that easy-to-name pictures that are more matched with compared to pictures that do not match, the prototypical pictures of their labels, are more influenced by their verbal labels because the effect of the prototypical picture becomes larger. Hence, the interfering effect should be found to be strong when the labels (appropriate labels) are linked with prototypical pictures that match the shapes (Hamilton & Geraci, 2006; Vaidya & Gabrieli, 2000). In contrast, Brandimonte and Collina propose that verbal coding results in a shift from featural to global representations. They did not systematically examine the role of the match between easy-to-name shapes and their labels in the visual imagery domain. However, it can be assumed, based on a shift between global to featural visual representations, that verbal labels, regardless of their match to the shapes, may cause similar impairing effects. This is because verbal labeling makes participants rely on the global representations at retrieval. Global representations do not suit the imagery task (Kosslyn, 1994), and hence, according to the shift in emphasis account by Brandimonte and Collina, applying verbal labels at encoding would not help performance.

The shift in emphasis account by Brandimonte and Collina (2008) can explain findings from the spatial-temporal presentation method. The explanation for interfering effects of both covert spontaneous naming and explicit labelling in the spatial-temporal presentation method was that the verbal interfering effects were shown because spontaneous naming and explicit labelling were used to recode the shapes and shift the genuine featural visual representation of the shape to a new global representation that has lost the original details. Imagery performance requires access to the highly detailed representation (Kosslyn, 1980), and thus, performance is impaired via spontaneous naming and explicit labelling. Additionally, Brandimonte and Collina showed that it is possible to remove the interfering effect via explicit labels by re-presenting labels that match the features of the shapes as cues at retrieval. This is because presenting the verbal labels that correspond to features of the shapes can shift the representation back to a featural representation, and this improves performance. In contrast, verbal labels that do not match the detailed features of the shapes cannot improve performance when used as cues at retrieval. This illustrates that the shift in emphasis account by Brandimonte and Collina, that involves the shift between featural and global visual representations, can explain the role of spontaneous naming and explicit labelling in the spatial-temporal presentation method.

Moving to the temporal presentation method, the findings from this thesis demonstrated positive effects of covert spontaneous naming during encoding on both easy-to-name shapes and hard-to-name shapes in both a mental rotation paradigm (Experiments 1 and 2) and a mental subtraction paradigm (Experiment 7). Additionally, the findings from this thesis showed a positive role for verbal information at retrieval. Evidence for this comes from the negative effect of AS and preload tasks at retrieval for performance in the mental rotation task (Experiment 2). This indicates that participants use verbal codes to access the shapes at retrieval. The shift in emphasis account cannot explain such findings because it predicts a negative effect of covert spontaneous naming during encoding as the verbal label should place an emphasis upon a non-veridical representation of the original shape (Lupyan, 2008) or a global representation that does not suit the task (Brandimonte & Collina, 2008). This was not the case for spontaneous naming in the temporal presentation method where covert spontaneous naming helped performance. Additionally, the shift in emphasis account does not predict a positive role for verbal information at retrieval unless verbal information is matched with features of the shapes. However, it was found that both easy-to-name shapes and hard-to-name shapes benefited from verbal coding at retrieval (Experiment 2), although the two sets of shapes showed a different degree of match with their labels. The different levels of matches between the shapes and self-generated labels were shown in Experiment 4, where two judges rated to what extent the explicit self-generated labels matched the easy-to-name and hard-to-name shapes. Therefore, the shift in emphasis account cannot explain the role of spontaneous naming in the temporal presentation method.

One comment is on the findings from Experiment 4, where self-generated labels impaired performance on both easy-to-name and hard-to-name shapes, but showed a trend toward larger impairment for easy-to-name shapes. This was the case, although labels given to easy-to-name, compared to labels given to hard-to-name shapes, were judged to be more matched with their shapes. Together, these findings may indicate that a larger match between the labels and the shapes increases the impairing effect via self-generated labels. This idea is consistent with the shift in emphasis account by Lupyan (2008), where a closer match between the visual stimulus and the verbal label increases the impairing effect via the verbal label. Nevertheless, this idea is not consistent with findings from Experiment 5 and 8, which applied experimenter-generated labels to easy-to-name shapes. Here, appropriate labels that match the shapes, according to naming agreement test, showed less of an impairing effect on easy-to-name shapes compared to the impairing effect of nonwords, which do not match the easy-to-name shapes. However, one reason for the findings in Experiment 4 might be that hard-to-name shapes, which differ in their nature from easy-to-name shapes, are, generally, less affected by verbalization. Additionally, it should be emphasized that Experiment 4 did not show an interaction between the effect of the types of shapes (easy-to-name and hard-to-name shapes) and the effect of self-generated labels. Therefore, a replication of this finding is needed before a firm conclusion can be made. In contrast, the differential effect of appropriate labels and nonwords on performance for easy-to-name shapes was replicated in two experiments in this thesis (Experiments 5 and 8). Furthermore, the findings from Experiments 5 and 8 showed that both appropriate labels and nonwords can work as effective cues at retrieval. They removed the interfering effects of explicit labels and enhanced performance. These findings cannot be explained by a shift in emphasis account, which suggest that only verbal labels that correspond to the features of the shapes can improve performance. Thus, the role of the match between verbal labels and shapes in the temporal presentation method cannot be fully explained by the shift in emphasis accounts.

The role of spontaneous naming in the temporal presentation method may instead be explained by accounts which indicate that verbal information is encoded alongside visual information and that it is important at retrieval to access visual information (Bahrick & Bahrick, 1971; Pelizzon et al., 2002). The account by Bahrick and Bahrick assumes that covert spontaneous naming is conjointly encoded with visual information, and this may imply that the match between the shapes and their labels determine the positive role of spontaneous naming. In contrast, the idea by Pelizzon et al. indicates that covert spontaneous naming is used to encode order information in the temporal presentation method whereas visual codes are used to encode the shapes themselves. Findings from this thesis may support the idea by Pelizzon et al. and suggest that the verbal code is used to encode order information in the temporal presentation method. AS at encoding was found to show a negative effect on both easy-to-name and hard-to-name shapes in Experiment 2, using the mental rotation paradigm, and Experiment 7, using the mental subtraction paradigm. There was no interaction between the effect of AS and shape type. This shows that covert spontaneous naming was equivalently important for easy-to-name and hard-to-name shapes. Together, the findings from this thesis indicate that spontaneous naming in the temporal presentation method does not cause a shift of emphasis between different types of visual representation, whether featural to global representations (Brandimonte & Collina, 2008) or prototypical to veridical representations (Lupyan, 2008) but it allows conjoint encoding of verbal and visual information to be recalled in their serial order.

In contrast, explicit labels may not allow conjoint encoding of verbal and visual information in a unified representation which is important for performance in the temporal presentation method. This was shown via the negative effect of self-generated labels compared to covert spontaneous naming (Experiment 4) and the negative effect via experimenter-generated labels compared to covert spontaneous naming (Experiments 5 and 8).

The role of explicit labelling in the temporal presentation method is best explained by the pair association account. This account is related to the linking between the shapes and explicit labels. It shows that learning label-picture pairs requires access to both items of the pair at retrieval. Forgetting an item from the pair causes participants to forget the whole pair (Hockley & Bancroft, 2011). Hence, performance in the labelling conditions, both appropriate labels and nonwords, was lower than performance in the control condition, with no labels, in Experiment 5 and 8. This is because adding words, which are easy to forget compared to pictures (Ally & Budson, 2007; Nelson et al., 1976; Shepard, 1967), increases the possibility of forgetting items from label-picture pairs. This as a consequence leads to forgetting the whole pair. Additionally, this account indicates that pairing pictures with nonwords shows a larger impairing effect compared to pairing pictures with appropriate labels because nonwords are easily forgotten and, thus, they cause forgetting of the whole pair (Greene, 2004; Xu & Malmber, 2007). This was demonstrated in Experiment 5 (mental rotation) and Experiment 8 (mental subtraction), where larger interfering effects occurred for nonwords compared to appropriate labels during encoding. Furthermore, the pair association account indicates that re-presenting the verbal cues at retrieval can remove the interfering effects via explicit labels. This is based on findings from Verhaeghen et al. (2006) that presenting one member from the pair facilitates access to the second member in the pair. This improvement by verbal cues can be achieved by presenting both appropriate labels and nonwords. Indeed, findings from Experiments 5 and 8 in this thesis showed a positive effects for both appropriate and nonwords cues at retrieval.

All in all, the pair association view can account for the negative effect of explicit labelling in the temporal presentation method.

In contrast, the pair association account cannot explain the role of explicit labelling in the spatial-temporal presentation method. Experimenter-generated labels during encoding impaired performance for hard-to-name shapes but not for easy-to-name shapes in the spatial-temporal presentation method (Brandimonte et al., 1992a). The pair association account cannot explain such findings as this account predicts impairing effects that occur for both easy-to-name and hard-to-name shapes. Moreover, verbal cues that matched features of the shapes in the spatial-temporal presentation method were able to remove the interfering effect via explicit labelling after stimulus encoding. In contrast, verbal cues that did not match featural details of the shapes were not able to remove the interfering effects via explicit labelling (Brandimonte & Collina, 2008). These findings are not consistent with the pair association account whereby re-presenting verbal labels as cues at retrieval facilitates access to the shapes (Verhaeghen et al., 2006). Hence, the pair association account cannot explain the role of explicit labelling in the spatial-temporal presentation method.

In summary, findings from visual imagery studies illustrate that there is no unified theory to account for the role of the verbal code in visual memory. Task demands determine the underlying mechanisms that show verbal interference or verbal facilitation in visual memory. Covert spontaneous naming and explicit labelling in the spatial-temporal presentation method shows verbal interference via shifting the emphasis from featural to global representations (Brandimonte & Collina, 2008). In contrast, spontaneous naming in the temporal presentation method shows verbal facilitation by allowing conjoint encoding of verbal and visual information (Bahrick & Bahrick, 1971; Pelizzon et al., 2002). Finally, explicit labelling in the temporal presentation method shows verbal interference by linking verbal and visual information in pairs (Hockley & Bancroft, 2011).

Methodological Implications

Findings within each visual memory domain have identified particular task demands that mediate the role of verbalization. Findings in the face recognition domain, for instance, imply that description instructions mediate the role of verbalization in face recognition (Brown & Lloyd-Jones, 2002; 2005; 2006; MacLin et al., 2002; Meissner et al., 2001; Nakabayashi et al., 2011). Similarly, findings in the picture recognition domain identified task demands that mediate the role of verbalization in picture recognition. These task demands include, for example, the time when labelling takes place (Verhaeghen et al., 2006) and the contents of the labels (Ellis, 1968).

Additionally, the role of task demands in mediating verbal interference and verbal facilitation has been demonstrated across different domains in visual memory. Nakabayashi et al. (2011) and Brown & Lloyd-Jones (2003) indicate that the use of verbalisation may exert similar effects on face recognition and object recognition depending on task demands. For example, Nakabayashi et al., (2011) show that the time when overt verbal description takes place mediates verbal interference and verbal facilitation in both face recognition and object recognition. Concurrent overt description benefited recognition performance for objects but not for faces. However, post-verbal description (description following the encoding of the stimuli) impaired performance in both tasks. This latter finding implies that a particular task demand can exert similar effects on the role of the verbal code across different domains of visual memory.

The findings from this thesis which focused on the role of the verbal code in visual imagery identified the presentation method as an important task demand. It showed differential effects for spontaneous covert naming in the spatial-temporal presentation method and the temporal presentation method (Experiments 1, 2 and 3). Therefore, it appears that spatial information and temporal information provided to participants may be important mediators for the role of the verbal code in visual memory. The differences between the temporal and the spatial-temporal presentation method may be examined in face recognition and picture recognition paradigms. In face and picture recognition paradigms, series of items were, normally, presented in a sequential order, resembling the temporal presentation method (e.g., Nakabayashi et al., 2011; Verhaeghen et al., 2006). Presentation method may determine the role of the verbal code in visual recognition. Hence, examining the effects of AS during encoding with the temporal, spatial-temporal and spatial presentation methods in visual recognition may mirror findings in visual imagery paradigms. For example, AS may impair performance in the temporal presentation method and show a positive role for spontaneous naming (e.g., Nakabayashi & Burton, 2008; Nakabayashi et al., 2011). In contrast, it may not have a negative effect in the spatial-temporal and the spatial presentation method, where the verbal code does not seem to have a facilitative role. However, recognition of faces and highly similar objects relies on global processing (Yin, 1969) whereas visual imagery tasks rely on featural processing (Kosslyn, 1994). Therefore, the same task demand (e.g., presentation method) may, similarly, mediate the role of the verbal code across different domains, but comparing the effects of verbalization across different domains may give rise to different effects.

Conclusion

The main finding from this thesis was that different demands of the tasks cause verbal labelling to show interference or facilitation effects. Previous studies in face recognition and picture recognition provided evidence for the effect of task demands in showing verbal interference and verbal facilitation (e. g., Nakabayashi et al., 2011). This thesis demonstrated how task demands can influence verbal labelling to show the positive and negative effects on visual imagery; the temporal presentation method enabled demonstration of verbal interference and facilitation in visual imagery paradigms (mental rotation and mental subtraction). These findings highlight that certain task demands mediate verbal effects and this contributes to the theoretical accounts relating to the role of the verbal code in visual memory. In addition, this thesis was the first to apply the pair association account to explain the role of explicit labels in visual imagery. Finally, looking at the broad field of cognitive psychology, studies of the role of the verbal code in visual memory is of value to the broad question about the relationship between verbal and visual information in cognitive activities.

References

Adaval, R. & Wyer, R. S. (2004). Communicating about a social interaction: Effects on memory for protagonists' statements and nonverbal behaviors. *Journal of Experimental Social Psychology, 40,* 450-465.

Allison, T., Puce, A., Spencer, D. D. & McCarthy, G. (1999). Electrophysiological studies of human face perception. I: Potentials generated in occipitotemporal cortex by face and nonface stimuli. *Cerebral Cortex*, 9, 415–430.

Ally, B. A. & Budson, A. E. (2007). The worth of pictures: Using high density event related potentials to understand the memorial power of pictures and the dynamics of recognition memory. *NeuroImage, 35*, 378-395.

Anderson, R. E. (1976). Short-term retention of the where and when of pictures and words. *Journal of Experimental Psychology: General, 105,* 378-402.

Avons, S. E. (1998). Serial report and item recognition of novel visual patterns. *British Journal of Psychology, 89*, 285–308.

Baddeley, A. D. & Hitch, G. (1974). Working memory. In G. A. Bower (Ed), *The psychology of learning and motivation* (pp. 47-89). New York: Academic Press.

Bahrick, H. P. & Bahrick, P. (1971). Independence of verbal and visual codes of the same stimuli. *Journal of Experimental Psychology, 91,* 344-346.

Battig, W. F. (1962). Paired-associate learning under simultaneous repetition and non-repetition conditions, *Journal of Experimental Psychology, 64,* 87-93.

Bower, G. H. & Karlin, M. B. (1974). Depth of processing pictures of faces and recognition memory. *Journal of Experimental Psychology, 103,* 751-757.

Brandimonte, M. A. & Collina, S. (2008). Verbal overshadowing in visual imagery is due to recoding interference. *European Journal of Cognitive Psychology, 20,* 612-631.

Brandimonte, M. A., Schooler, J. W. & Gabbino, P. (1997). Attenuating verbal overshadowing through color retrieval cues. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23,* 915-931.

Brandimonte, M. A. & Gerbino, W. (1993) Mental image reversal and verbal recoding: When ducks become rabbits. *Memory & Cognition, 21,* 23-33.

Brandimonte, M. A., Hitch, G. J. & Bishop, D. V. (1992). Verbal recoding of visual stimuli impairs mental image transformations. *Memory & Cognition, 20,* 449-455.

Brandimonte, M. A., Hitch, G. J. & Bishop, D. V. (1992). Manipulation of Visual Mental Images in Children and Adults. *Journal of Experimental Child Psychology, 53,* 300-312.

Bransford, J. D. & Franks, J. J. (1971). Abstraction of linguistic ideas. Cognitive *Psychology, 2,* 331-350.

Brown, C., Gehrke, J. & Lloyd-Jones, T. (2010). A visual and semantic focus to beneficial effect of verbalization on face memory. *American Journal of Psychology, 123,* 51-69.

Brown, C. & Lloyd-Jones, T. (2006). Beneficial effects of verbalization and visual distinctiveness on remembering and knowing faces. *Memory & Cognition, 34,* 277-286.

Brown, C. & Lloyd-Jones, T. (2005). Verbal facilitation of face recognition. *Memory & Cognition, 33,* 1442-1456.

Brown, C. & Lloyd-Jones, T. (2003). Verbal overshadowing of multiple face and car recognition: Effects of within- versus across-category verbal descriptions. *Applied Cognitive Psychology,17,* 183-201.

Brown, C. & Lloyd-Jones, T. (2002). Verbal overshadowing in a multiple face presentation paradigm: Effects of description instruction. *Applied Cognitive Psychology, 16,* 873-885.

Brown, G., Neath, I. & Chater, N. (2007). A temporal ratio-model of memory. *Psychological Review, 114*, 539-576.

Brown, G., Preece, T. & Hulme, C. (2000). Oscillator-based memory for serial order. *Psychological Review, 107,* 127-181.

Burgess, N. & Hitch, G. J. (1999). Memory for serial order: A network model of the phonological loop and its timing. *Psychological Review, 106,* 551-581.

Calfee, R. C. & Atkinson, R. C. (1965). Paired-associate models and effects of list length. *Journal of Mathematical Psychology, 22,* 254-255.

Carmichael, L., Hogan, H. P. & Walter, A. A. (1932). An experimental study of the effect of language on the reproduction of visually perceived forms. *Journal of Experimental Psychology, 15,* 73-86.

Carr, T. H., McKauley, C., Sperber, R. D. & Parmelee, C. M. (1982). Word, picture, and priming on semantic activation, conscious identification, and the automaticity of information processing. *Journal of Experimental Psychology: Human Perception and Performance, 8,* 757-777.

Catalan, M. J., Honda, M., Weeks, R. A., Cohen, L. G. & Hallett, M. (1998). The functional neuroanatomy of simple and complex sequential finger movements: A PET study. *Brain, 121*, 253–264.

Chin, J. M. & Schooler, J. W. (2008). Why do words hurt? Content, process, and criterion shift accounts of verbal overshadowing. *European Journal of Cognitive Psychology, 20,* 396–413.

Clare, J. & Lewandowsky, S. (2004). Verbalizing Facial Memory: Criterion Effects in Verbal Overshadowing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30,* 739-755.

Clark, H. H. (1973). The language-as-fixed-effect fallacy: A critique of language statistics in psychological research. *Journal of Verbal Learning and Verbal Behaviour, 12,* 335-359.

Clark, L. L., Lansford, T. G. & Dallenbach, K. M. (1960). Repetition and associative learning, *The American Journal of Psychology, 73*, 22-40.

Cocchini, G., Logie, R. H., Della Sala, S. MacPherson, S. E. & Baddeley, A. D. (2002) Concurrent performance of two memory tasks: Evidence for domain-specific working memory systems. *Memory & Cognition*, *30,* 1086-1095.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.* Hillsdale: Erlbaum.

Craik, F. I. M. & Lockhart, R. S. (1972) Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behaviour, 11,* 671-688.

Dainoff, M. J. (1970). Time course of visual and auditory encoding. *Journal of Experimental Psychology*, *86,* 214-224.

Daniel, T. C. & Toglia, M. P. (1976). Recognition gradients for random shapes following distinctive or equivalent verbal association training. *Journal of Experimental Psychology Human learning and memory, 2*, 467-474.

Deffenbacher, K., Carr, T. & Leu, J. (1981). Memory for words, pictures, and faces: Retroactive interference, forgetting and reminiscence. *Journal of Experimental Psychology: Human Learning and Memory, 7,* 299-305.

Del Castillo, D. M. & Gumenic, W. E. (1972). Sequential memory for familiar and unfamiliar forms. *Journal of Experimental Psychology, 95*, 90-96.

Depoorter, A. & Vandierendonck, A. (2009). Evidence for modality-independent order coding in working memory. *Quarterly Journal of Experimental Psychology, 62*, 531-549.

Deutsch, D. (1974) Generality of interference by tonal stimuli in recognition memory for pitch. *Quarterly Journal of Experimental Psychology, 26*, 229-234.

Dodson, C. S. Johnson, M. K. & Schooler, J. W. (1997). The verbal overshadowing effect: Why descriptions impair face recognition. *Memory & Cognition. 25,* 129-139.

Dougal, S. & Rotello, C. M. (1999). Context effects in recognition memory. *American Journal of Psychology, 112*, 277-295.

Diamond, R. & Carey**,** S. (1986). Why faces are and are not special: An effect of expertise. *Journal of Experimental Psychology: General, 115*, 107-117.

Ellis, H. C. (1968). Transfer of stimulus predifferentiation to shape recognition and identification learning role of properties of verbal labels. *Journal of Experimental Psychology, 78* , 401-409.

Emerson, M. J. & Miyake, A. (2003). The role of inner speech in task switching: A dual-task investigation. *Journal of Memory and Language, 48*, 148-168.

Eriksen, C. W., Webb, J. M. & Fournier, L. R. (1990). How much processing do nonattended stimuli receive? Apparently very little, but... *Perception & Psychophysics, 47*, 477-488.

Fallshore, M. & Schooler, J. W. (1995). Verbal vulnerability of perceptual expertise. *Journal of Experimental Psychology: Learning, Memory, and Cognition. 21*, 1608-1623.

Finger, K. (2002). Mazes and music: Using perceptual processing to release verbal overshadowing. *Applied Cognitive Psychology, 16,* 887-896.

Finger, K. & Pezdek, K (1999). The effect of cognitive interview on face identification accuracy: Release from verbal overshadowing. *Journal of Applied Psychology. 84*, 340-348.

Finke, R. A., Pinker, S. & Farah, M. (1989). Reinterpreting visual patterns in mental imagery. *Cognitive Science*, *13*, 51-78.

Fiore, S. M. & Schooler, J. W. (2002). How did you get here from there? Verbal overshadowing of spatial mental models. *Applied Cognitive Psychology, 16,* 897-910.

Francis, G. (2012). The psychology of replication and replication in psychology. *Perspectives on Psychological Science, 7,* 585-594.

Franks, J. J. & Bransford, J. D. (1971). Abstraction of visual patterns. *Journal of Experimental Psychology, 90,* 65-74.

Gauthier, I. & Tarr, M. J. (2002). Unraveling mechanisms for expert object recognition: Bridging brain activity and behavior. *Journal of Experimental Psychology: Human Perception and Performance, 28*, 431–446.

Gilhooly, K. J., Logie, R. H., Wetherick, N. E. & Wynn, V. (1993). Working memory and strategies in syllogistic-reasoning tasks. *Memory & Cognition, 21*, 115-124.

Glanzer, M., Dorfman, D. & Kaplan, B. (1981). Short-term storage in the processing of text. *Journal of Verbal Learning and Verbal Behavior, 20*, 656-670.

Greene, R. L. (2004). Recognition memory for pseudowords. *Journal of Memory & Language, 50***,** 259-267.

Grill-Spector, K. & Kanwisher, N. (2005). Visual recognition: As soon as you know what it is there, you know what it is. *Psychological Science, 16,* 152-160.

Halgren, E., Raij, T., Marinkovic, K., Jousmäki, V. & Hari, R. (2000). Cognitive response profile of the human fusiform face area as determined by MEG. *Cerebral Cortex, 10*, 69–81.

Halsband, U., Ito, N., Tanji, J. & Freund, H. J. (1993). The role of premotor cortex and the supplementary motor area in the temporal control of movement in man. *Brain, 116,* 243–266.

Hamilton, M. & Geraci, L. (2006). The picture superiority effect in conceptual implicit memory: A conceptual distinctiveness hypothesis. *American Journal of Psychology*, *119,* 1-20.

Hasher , L. & Zacks, R. (1979). Automatic and effortful processes in memory. *Journal of Experimental Psychology: General*, *108*, 356-388.

Healy, A. F. (1982). Short-term memory for order distribution of information. *Journal of Verbal Learning and Verbal Behavior, 8,* 378-383.

Healy, A. F. (1974). Separating item from order information in short-term memory. *Journal of Verbal Learning & Verbal Behavior, 13*, 644-655.

Henson, R., Hartley, T., Burgess, N., Hitch, G. & Flude, B. (2003). Selective interference with verbal short-term memory for serial order information: A new paradigm and tests of a timing-signal hypothesis. *Quarterly Journal of Experimental Psychology, 56A,* 1307-1334.

Hitch, G. J., Brandimonte, M. A. & Walker, P. (1995). Two types of representation in visual memory: Evidence from the effects of stimulus contrast on image combination. *Memory & Cognition*, *23,* 147-154.

Hitch, G. J., Woodin, M. E. & Baker, S. (1989). Visual and phonological components of working memory in children. *Memory & Cognition, 17*, 175-185.

Hockley, W. E. & Bancroft, T. (2011). Extensions of the picture superiority effect in associative recognition. *Canadian Journal of Experimental Psychology/Revue, 65,* 236-244.

Huff, M. & Schwan, S. (2008). Verbalizing events: Overshadowing or facilitation? *Memory & Cognition, 36,* 392– 402.

Hunt, C. & Carroll, M. (2008). Verbal overshadowing effect: How temporal perspective may exacerbate or alleviate the processing shift. *Applied Cognitive Psychology, 22,* 85-93.

Intraub, H. & Nicklos, S. (1985). Levels of processing and picture memory: The physical superiority effect. *Journal of Experimental Psychology: Learning, Memory & Cognition, 11***,** 284-298.

Jones, D., Farrand, P., Stuart, G. & Morris, N. (1995). Functional equivalence of verbal and spatial information in serial short-term memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 1008–1018.

Kay, H. & Skemp, R. (1956). Differential thresholds for recognition: Further experiments on interpolated recall and recognition. ***The Quarterly Journal of Psychology, 8,*** 153-162.

Kahneman, D. (1973). *Attention and Effort*. Englewood Cliffs, NJ: Prentice-Hall.

Kanwisher, N., McDermott, J. & Chun, M. (1997). The fusiform face area: A module in human extrastriate cortext specialized for face perception. *Journal for Neuroscience, 17,* 4302-4311.

Kelley, W. M., Miezin, F. M., McDermott, K. B., Buckner, R. L., Raichle, M. E. & Cohen, N. J. et al. (1998). Hemispheric specialization in human dorsal frontal cortex and medial temporal lobe for verbal and nonverbal memory encoding. *Neuron, 20,* 927-936.

Kerr, N. H. & Winograd, E. (1982). Effects of contextual elaboration on face recognition. *Memory & Cognition, 10,* 603-609.

Kimble, G. A. & Perlmuter, L. C. (1970). The problem of volition. *Psychological Review, 77,* 361-384.

Kitagami, S., Sato, W. & Yoshikawa, S. (2002). The influence of test-set similarity in verbal overshadowing. *Applied Cognitive Psychology, 16*, 963-972.

Klatzky, R. L., Martin, G. L. & Kane, R. A. (1982). Semantic interpretation effect on memory for faces. *Memory & Cognition, 10*, 195–206.

Kosslyn, S. M. (1994). *Image and Brain: The Resolution of the Imagery Debate.* MIT Press: Cambridge.

Laughery, K. R. & Pinkus, A. L. (1966). Short-term memory: Effects of acoustic similarity, presentation rate and presentation mode. *Psychonamic Science, 6,*285-286.

Lee, C. L. & Estes, W. K. (1981). Item and order information in short-term memory: Evidence for multilevel perturbation processes. *Journal of Experimental Psychology: Human Learning and Memory, 7,* 149-169.

Lewandowsky, S. & Hockley, W. E. (1987). Does 'charm'need depth? Similarity and levels of processing effects in cued recall. *Journal of Experimental Psychology: Learning, Memory & Cognition*, *13,* 443-455.

Lloyd-Jones, T. J., Brandimonte, M. A. & Bäuml, K. H. (2008). Verbalizing visual memories, *European Journal of Cognitive Psychology, 20*, 387-395.

Lloyd-Jones, T. & Brown, C. (2008). Verbal overshadowing of multiple face recognition: Effects on remembering and knowing over time. *European Journal of Cognitive Psychology, 20,* 456-477.

Lloyd-Jones, T., Brown, C. & Clarke, S. (2006) Verbal overshadowing of perceptual discrimination. *Psychonomic Bulletin and Review*, *13*, 269-274.

Lockhart, R. S. & Craik, F. I. (1990). Levels of processing: A retrospective commentary on a framework for memory research. *Canadian Journal of Psychology Review, 44,* 87-112.

Logie, R. H., Della Sala, S., Wynn, V. & Baddeley, A. D. (2000). Visual similarity effects in immediate verbal serial recall. *Quarterly Journal of Experimental Psychology, 54A,* 626–646.

Logie, R. H., Zucco, G. M. & Baddeley, A. D. (1990). Interference with visual short-term memory. *Acta Psychologica, 75,* 55-74.

Lupyan, G. (2008). From chair to chair: A representational shift account of object labeling effects on memory, *Journal of Experimental Psychology, 137,* 348-369.

Lyle, K. & Johnson, M. K. (2004). Effects of verbalization on lineup face recognition in an interpolated inspection paradigm. *Applied Cognitive Psychology*, *18*, 393-403.

MacLin, O, Tapscott, R. & Malpass, R. S. (2002). The development of a computer system to collect descriptions of culprits. *Applied Cognitive Psychology*, *16,* 937-945.

MacLin, M. (2002). The effects of exemplar and prototype descriptors on verbal overshadowing. *Applied Cognitive Psychology, 16*, 929-936.

Macrae. C. N. & Lewis, H. L. (2002). Do I Know you? Processing orientation and face recognition. *Psychological Science*, *13,* 194-196.

Makel, M. C., Plucker, J. A. & Hegarty, B. (2012). Replications in psychology research: How often do they really occur? *Perspectives on Psychological Science, 7,* 537-542.

Mandler, J. & Ritchey, G. (1977). Long-term memory for pictures. *Journal of Experimental Psychology; Human Learning and Memory, 3,* 388-396.

Massaro, D. W. (1970). Retroactive interference in short-term recognition memory for pitch. *Journal of Experimental Psychology, 83,* 32-39.

Mazard, A., Laou, L., Joliot, M. & Mellet, E. (2005). Neural impact of the semantic content of visual mental images and visual percepts. *Cognitive Brain Research, 24,* 423-435.

McKone, E. (1995). Short-term implicit memory for words and nonwords. *Journal of Experimental Psychology: Learning, Memory & Cognition, 21*, 1108-1126.

Meissner, C. A., Sporer, S. L., & Susa, K. J. (2008). A theoretical review and meta-analysis of the description-identification relationship in memory for faces. *European Journal of Cognitive Psychology, 20*, 414–455.

Meissner, C. A. (2002). Applied aspects of the instructional bias effect in verbal overshadowing. *Applied Cognitive Psychology, 16,* 911-928.

Meissner, C. A. & Brigham, J. C. (2001). A meta analysis of the verbal overshadowing effect in face identification. *Applied Cognitive Psychology, 15*, 603-616.

Meissner, C. A., Brigham, J. C. & Kelley, C. M. (2001). The influence of retrieval processes in verbal overshadowing. *Memory & Cognition*, *12*, 176-186.

Melcher, J. M. & Schooler, J. W. (2004). Perceptual and conceptual training mediate the verbal overshadowing effect in an unfamiliar domain. *Memory & Cognition*, *32*, 618-631.

Melcher, J. M. & Schooler, J. W. (1996). The misremembrance of wines past: Verbal and perceptual expertise differentially mediate verbal overshadowing of taste memory. *Journal of Memory and Language, 35,* 231-245.

Memon, A. & Bartlett, J. (2002). The effects of verbalization on face recognition in young and older adults. *Applied Cognitive Psychology,* 16, 635-650.

Minamoto, T., Osaka, M., Engle, R. W. & Osaka, N. (2012). Incidental encoding of goal irrelevant information is associated with insufficient engagement of the dorsal frontal cortex and the inferior parietal cortex. *Brain Research, 6*, 82-97.

Mitchell, D. B. & Brown, A. S. (1988). Persistent repetition priming in picture naming and its dissociation from recognition memory. *Journal of Experimental Psychology: Learning, Memory & Cognition, 14,* 213-222.

Morey, C. & Cowan, N. (2004). When visual and verbal memories compete: Evidence of cross domain limits in working memory. *Psychonamic Bulletin and Review, 11,* 296-301.

Murnane, K. & Phelps, M. P. (1995). Effects of Changes in Relative Cue Strength on Context-dependent Recognition. *Journal of Experimental Psychology: Learning, Memory & Cognition, 19,* 882-894.

Murnane, K. & Phelps, M. P. (1993). A global activation approach to the effect of changes in the environmental context on recognition. *Journal of Experimental Psychology: Learning, Memory & Cognition, 19,* 882-894.

Musen, G. (1991). Effects of verbal labelling and exposure duration on implicit memory for visual patterns. *Journal of Experimental Psychology: Learning. Memory & Cognition, 17,* 954-962.

Nairne, J. S. & Dutta (1992). Spatial and temporal uncertainty in long-term memory. *Journal of Memory & Language*, *31*, 396-407.

Nakabayashi, K., Lloyd-Jones, T. J. Butcher, N. & Liu, C. H. (2012). Independent influences of verbalization and race on the configural and featural processing of faces: A behavioral and eye movement study. *Journal of Experimental Psychology: Learning, Memory & Cognition, 38,* 61-77.

Nakabayashi, K., Burton, M, Brandimonte, M. A. & Lloyd-Jones, T. J. (2011). Dissociating positive and negative influences of verbal processing on the recognition of pictures of faces and objects. *Learning Memory & Cognition, 37,* 376-390.

Nakabayashi, K. & Burton, A. M. (2008). The role of verbal processing at different stages of recognition memory for faces. *European Journal of Cognitive Psychology, 20,* 478-496.

Naveh-Benjamin, M. (1987). Coding of spatial location information: An automatic process? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15,* 859-867.

Nelson, K. E. & Kosslyn, S. M. (1976). Recognition of previously labelled or unlabelled pictures by five-year-olds and adults. *Journal of Experimental Child Psychology, 21,* 40-45.

Nelson, D. L., Reed, V. S. & Walling, J. R. (1976). Pictorial superiority effect. *Journal of Experimental Psychology: Human Learning & Memory, 2,* 523-528.

Noyes, J. M. & Garland, K. J. (2008). Computer- vs. Paper-based tasks: Are they equivalent? *Ergonomics, 51,* 1352-1375.

Oldfield, R. C. & Wingfield, A. (1965). Response latencies in naming objects. *Quarterly Journal of Experimental Psychology, 17,* 273-281.

Page, M. P. & Norris, D. (1998). The primacy model: A new model of immediate serial recall. *Psychological Review, 105*, 761-781.

Paivio, A,. Philipchalk, R. & Rowe, E. (1975). Free and serial recall of pictures, sounds and words. *Memory & Cognition, 3,* 586-590.

Paivio, A. & Csapo, K. (1969). Concrete image and verbal memory codes. *Journal of Experimental Psychology, 80,* 279-285.

Parkin, A. J. & Russo, R. (1990). Implicit and explicit memory in the automated effortful distinction. *European Journal of Cognitive Psychology, 2,* 71-80.

Pashler, H. & Harris, C. (2012). Is the replicability crisis overblown? Three arguments examined. *Perspectives on Psychological Science, 7,* 531-536.

Pelizzon, L., Brandimonte, M. A. & Luccio, R. (2002). The role of visual, spatial, and temporal cues in attenuating verbal overshadowing. *Applied Cognitive Psychology, 16*, 947-961.

Pelizzon, L., Brandimonte, M. A. & Favretto, A. (1999). Imagery and recognition: Dissociable measures of memory? *European Journal of Cognitive Psychology, 11*, 429-443.

Phillips, J. L., Shiffrin, R. M. & Atkinson, R. C. (1967). Effects of list length in short-term memory. *Journal of Verbal Learning and Verbal Behavior, 6,* 303-311.

Pickering, S. J., Gathercole, S. E. & Peaker, S. M. (1998). Verbal and visuo-spatial short-term memory in children: Evidence for common and distinct mechanisms. *Memory & Cognition, 26,* 1117–1130.

Poirier, M. Saint-Aubin, J. & Musselwhite, K. (2007). Visual similarity effects on short term memory for order: The case of verbally labelled pictorial stimuli. *Memory & Cognition, 35,* 711-723.

Postman, L. & Phillips, L. (1965). Short-term temporal changes in free recall. *Quarterly Journal of Experimental Psychology, 17,* 132-138.

Postman, L. (1962). Repetition and paired associate learning. *American Journal of Psychology, 75*, 372-389.

Puce, A., Allison, T., Asgari, M., Gore, J. C. & McCarthy, G. (1996). Differential sensitivity of human visual cortex to faces, letterstrings, and textures: A functional magnetic resonance imaging study. *Journal of Neuroscience, 16*, 5205–5215.

Quinn, J. G. & McConnell, J. (2006). The interval for interference in conscious visual imagery. *Memory, 14*, 241-252.

Raaijmakers, J. G., (2003). A further look at the language-as-fixed-effect fallacy. Canadian *Journal of Experimental Psychology, 57*, 141-151.

Raaijmakers, J. G., Schrijnemakers, J. M., & Gremmen, F. (1999). How to deal with "the language-as-fixed-effect fallacy": Common misconceptions and alternative solutions. *Journal of Memory and Language, 41*, 416–426.

Rastle, K., Harrington, J. & Coltheart, M. (2002). 358,534 nonwords: The ARC Nonword Database. *Quarterly Journal of Experimental Psychology, 55A*, 1339-1362.

Rock, I. (1957). The role of repetition in associative learning. *American Journal of Psychology, 70*, 186-193.

Roodenrys, S. & Hinton, Melinda. (2002). Sublexical or lexical effects on serial recall of nonwords? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28*, 29-33.

Rosch, E. (1975). Cognitive representation of semantic categories. *Journal of Experimental Psychology: General, 104*, 192–233.

Saint-Aubin, J. & Poirier, M. (1999). The influence of long-term memory factors on immediate serial recall: An item and order analysis. *International Journal of Psychology, 34*, 347-352.

Sakai, K. & Miyashita, Y. (1991). Neural organization for the long-term memory of paired associates. *Nature, 354,* 152-155.

Santa, J. (1975). Verbal coding and redintegrative memory for shapes. *Journal of Experimental Psychology: Human Learning and Memory, 1*, 286-294.

Schmitt, B. M. Munte, T. F. & Kutas, M. (2000). Electrophysiological estimates of the time course of semantic and phonological encoding during implicit picture naming. *Psychophysiology, 37,* 473-484.

Schooler, J. W. (2002). Verbalization produces a transfer inappropriate processing shift. *Applied Cognitive Psychology, 16,* 989-997.

Schooler, J. W. & Engstler-Schooler, T. (1990). Verbal overshadowing of visual memories: Some things are better left unsaid. *Cognitive Psychology, 22,* 36-71.

Shepard, R. (1967). Recognition Memory for Words, Sentences and Pictures. *Journal of Verbal Learning and Verbal Behavior, 6,* 156-163.

Simmons, J. P., Nelson, L. D. & Simonsohn, U. (2011). False–positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science,* 22, 1359–1366.

Shiffrin, R. M. (1970). Forgetting: Trace erosion or retrieval failure. *Science, 168,* 1601-1603.

Smyth, M. M., Hay, D. C., Hitch, G. J. & Horton, N. J. (2005). Serial position memory in the visual-spatial domain: Reconstructing sequences of unfamiliar faces. *Quarterly Journal of Experimental Psychology, 58A*, 909–930.

Smyth, M. M. & Scholey, K. A. (1996). Serial order in spatial immediate memory. *Quarterly Journal of Experimental Psychology, 494*, 159-177.

Thorn, A. & Frankish, C. (2205). Long-Term Knowledge Effects on Serial Recall of Nonwords Are Not Exclusively Lexical. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*, 729-735.

Troyer, A. K. & Craik, F. I. (2000). The effect of divided attention on memory for items and their context. *Canadian Journal of Experimental Psychology Revue, 54,* 161-171.

Vaidya, C. J. & Gabrieli, J. D. E. (2000). Picture superiority in conceptual memory: Dissociative effects of encoding and retrieval tasks. *Memory & Cognition, 28,* 1165–1172.

Vandenberghe, R., Price, C., Wise, R., Josephs, O. & Frackowiak, R. (1996). Functional anatomy of a common semantic system for words and pictures. *Nature, 383,* 254-256.

Verhaeghen, P., Palfai, T. & Johnson, P. (2006). Verbal labelling as an assimilation mnemonic for abstract visual stimuli: The sample case of recognition memory for Chinese Characters. *Memory & Cognition, 34,* 795-803.

Verhaeghen, P., Cerella, J. & Basak, C. (2004). A working memory workout: How to expand the focus of serial attention from one to four items in 10 hours or less. *Journal of Experimental Psychology: Learning, Memory & Cognition, 30,* 1322-1337.

Weiss, W. & Margollus, G. (1954). The effect of context stimuli on learning and retention. *Journal of Experimental Psychology, 48*, 318-322.

Weldon, M. S., Roediger, H. L. & Challis, B. H. (1989). The properties of retrieval cues constrain the picture superiority effect. *Memory & Cognition, 17,* 95-105.

Wells, G. L. & Hryciw, B. (1984). Memory for faces: Encoding and retrieval operations. *Memory & Cognition, 12*, 338-344.

Weston, N. J., Perfect, T. J., Schooler, J. W. & Dennis, I. (2008). Navon processing and verbalisation: A holistic/featural distinction. *European Journal of Cognitive Psychology, 20*, 587-611.

Wickham, L. H. V. & Swift, H. (2006). Articulatory suppression attenuates the verbal overshadowing effect: A role for verbal encoding in face identification. *Applied Cognitive Psychology, 20,* 157-169.

Wilson, T. D. & Schooler, J. W. (1991). Thinking too much: introspection can reduce the quality of preferences and decisions. *Journal of Personality and Social Sciences, 60,* 181-192.

Winograd, E. (1981). Elaboration and distinctiveness in memory for faces. *Journal of Experimental Psychology: Human Learning & Memory, 7,* 181-190.

Xu, J. & Malmberg, K. J. (2007). Modeling the effects of verbal and nonverbal pair strength on associative recognition. *Memory & Cognition, 35***,** 526-544.

Yin, R. K. (1969). Looking at upside-down faces. *Journal of Experimental Psychology, 81*, 141-145.

Appendix A: Licence for Reprinting Figures from Brandimonte et al. (1992a)

SPRINGER LICENSE
TERMS AND CONDITIONS

Mar 07, 2013

This is a License Agreement between Sumyah Alnajashi ("You") and Springer ("Springer") provided by Copyright Clearance Center ("CCC"). The license consists of your order details, the terms and conditions provided by Springer, and the payment terms and conditions.

All payments must be made in full to CCC. For payment instructions, please see information listed at the bottom of this form.

License Number	3103621220541
License date	Mar 07, 2013
Licensed content publisher	Springer
Licensed content publication	Memory & Cognition
Licensed content title	Verbal recoding of visual stimuli impairs mentalimagetransformations
Licensed content author	Maria A. Brandimonte
Licensed content date	Jan 1, 1992
Volume number	20
Issue number	4
Type of Use	Thesis/Dissertation
Portion	Figures
Author of this Springer article	No
Order reference number	
Title of your thesis / dissertation	The Role of the Verbal Code in Visual Memory
Expected completion date	Mar 2013
Estimated size(pages)	200
Customer Tax ID	n/a
Total	0.00 USD
Terms and Conditions	

Introduction
The publisher for this copyrighted material is Springer Science + Business Media. By clicking "accept" in connection with completing this licensing transaction, you agree that the following terms and conditions apply to this transaction (along with the Billing and Payment terms and conditions established by Copyright Clearance Center, Inc. ("CCC"), at the time that you opened your Rightslink account and that are available at any time at http://myaccount.copyright.com).

Limited License
With reference to your request to reprint in your thesis material on which Springer Science and Business Media control the copyright, permission is granted, free of charge, for the use indicated in your enquiry.

Appendix B: Participant-based Analyses for Experiment 1

As each participant was presented with six shapes, and each shape consisted of two letters, the maximum number of correct answers was 12. A proportionally corrected score for each participant was calculated by dividing the number of correct answers by the total number of possible answers. See Figure 20 for the means of proportionally corrected scores in each condition.

A 2 (presentation method: temporal vs. spatial-temporal presentation) x 2 (AS at encoding: AS at encoding vs. control) ANOVA between group design showed no significant main effect for the method of presentation at encoding, F (1, 56) = .17, p = ns, MSe = .07, η^2p= .06. When collapsing across control and AS at encoding, no difference was found between the temporal presentation method (M = .44, SD = .3) and the spatial-temporal presentation method (M = .41, SD = .25). No significant main effect of the AS at encoding was found, F (1, 56) = .99, p = ns, MSe = .07, η^2p= .02. When collapsing across temporal and spatial-temporal presentation, performance in the control conditions (M = .46, SD = .27) was not higher than performance on AS at encoding condition (M = .39, SD = .26). No significant interaction was found between the AS at encoding and the presentation method at encoding, F (1, 56) = 2.22, p = ns, MSe = .07, η^2p= .14.

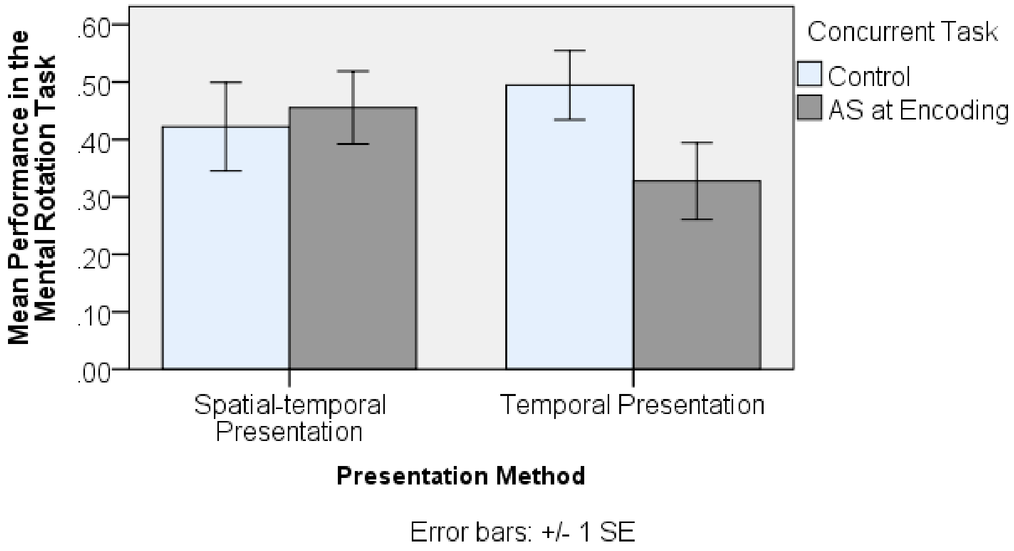


Figure 20. Performance in the rotation task in Experiment 1, expressed by the proportion correct score for participants in each condition.

A one way ANOVA between the control condition and the AS at encoding in the temporal presentation condition shows a marginally significant difference between performance in the control condition (*M* =.49, *SD* =.23) and performance on AS at encoding (*M* =.33, *SD* = .26), F (1, 28) = 3.45, p = .074, *MSe* = .06, $\eta^2 p$= .11.

A one way ANOVA between the AS at encoding condition and the control condition in the spatial-temporal presentation condition showed no significant difference between performance in the control condition (*M* =.42, *SD* =.3) and performance on AS at encoding (*M* =.46, *SD* = .25), F (1, 28) = .112, p = ns, *MSe* = .75, $\eta^2 p$= .004.

Appendix C: Participant-based Analyses for Experiment 2

As each participant was presented with six shapes, and each shape consisted of two letters, the maximum number of correct answers was 12. A proportionally corrected score for each participant was calculated by dividing the number of correct answers by the total number of possible answers. See Figure 21 for the means of proportionally corrected scores in each condition. A 2 (shape type: easy-to-name vs. hard-to-name shapes) x 4 (concurrent task: control, AS at encoding, AS at retrieval, and preload) between group design ANOVA revealed a significant main effect of the shape type on participants performance in the rotation task, F (1,112) = 11.037, p = .001, MSe = .062, η^2p= .09. Performance for easy-to-name shapes (M = .41, SD = .23) was higher than performance for hard-to-name shapes (M = 26, SD = .28). The main effect of concurrent tasks, control (M = .46, SD = .25), AS at encoding (M = .23, SD = .23), AS at retrieval (M = .34, SD = .26), and preload at retrieval (M = .32, SD = .29), on performance in the rotation task was significant, F (3,112) = 4.47, p = .005, MSe = .062, η^2p= .1. The effects of the retrieval tasks did not interact with the shape type, F (3,112) = .11, p = ns.

Post hoc comparisons using the Tukey HSD test indicated that performance for the control condition (M = .46, SD = .25) was significantly higher than AS at encoding condition (M = .23, SD = .23), $p < .05$. However, the control condition (M = .46, SD = .25) was not significantly higher than AS at retrieval (M = .34, SD = .26), p = ns. Finally, performance for the control condition (M = .46, SD = .25) was not significantly higher than preload at retrieval (M = .32, SD = .29), p = ns. All other comparisons were not significant, p = ns.

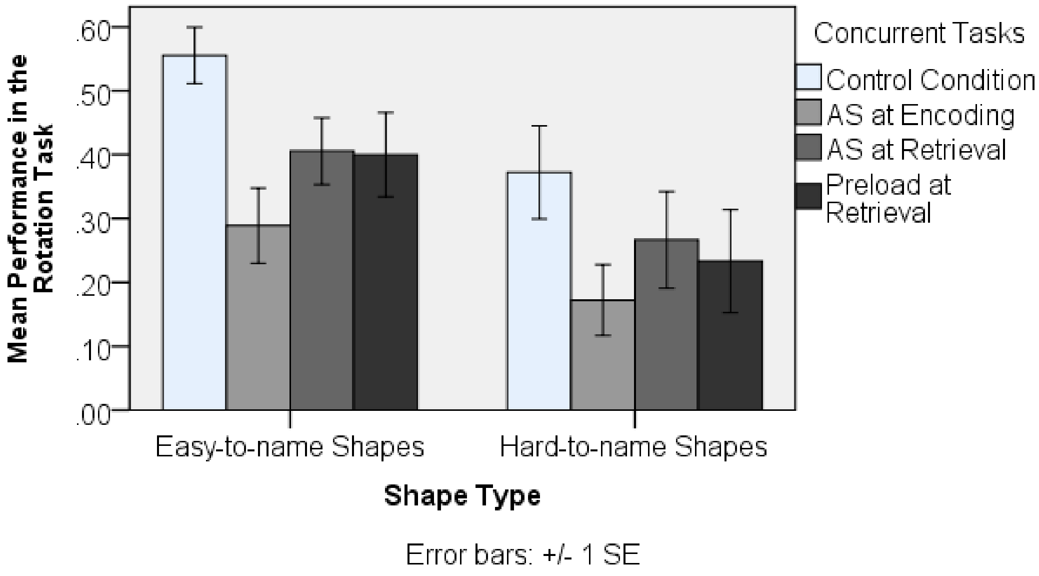


Figure 21. Performance in the rotation task in Experiment 2, expressed by the proportion correct score for participants in each condition.

Difference scores were explored by calculating the differences in the means between the control condition and each of the concurrent task groups. A 2 (shape type: easy-to-name vs. hard-to-name shapes) x 3 (the size of the difference between the control condition and each concurrent task: AS at encoding, AS at retrieval, and preload) between group design ANOVA did not reveal a significant main effect of the shape type on the size of differences of the concurrent tasks, F (1, 84) = .42, p = ns, MSe = .1, η^2p= .01. The size of differences for easy-to-name shapes (M = .19, SD = .29) was not larger than the size of differences for hard-to-name shapes (M = .15, SD = .35). The main effect of concurrent tasks AS at encoding (M = .23, SD = .28), AS at retrieval (M = .13, SD = .34), and preload at retrieval (M = .15, SD = .34), on performance in the rotation task was not significant, F (2, 84) = .92, p = ns, MSe = .1, η^2p= .02. The effects of the concurrent tasks did not interact with the shape type, F (2, 84) = .05, p = ns.

Appendix D: Participant-based Analyses for Experiment 3

As each participant was presented with six shapes, and each shape consisted of two letters, the maximum number of correct answers was 12. A proportionally corrected score for each participant was calculated by dividing the number of correct answers by the total number of possible answers. See Figure 22 for the means of proportionally corrected scores in each condition. A one way ANOVA between the control condition (*M* = .47, *SD* = .3), AS at encoding (*M* = .41, *SD* = .34) and preload at retrieval (*M* = .41, *SD* = .24) revealed no significant effect of the concurrent tasks, *F* (1, 42) = .195, *p* = ns, *MSe* = .09, $\eta^2 p$= .01. A one way ANOVA between the control condition (*M* = .47, *SD* = .3) and AS at encoding (*M* = .41, *SD* = .34) revealed no significant effect of the concurrent task, *F* (1, 28) = .23, *p* = ns, *MSe* = .01, $\eta^2 p$= .1. A one way ANOVA between the control condition (*M* = .47, *SD* = .3) and preload at retrieval (*M* = .41, *SD* = .24) revealed no significant effect of the concurrent task, *F* (1, 28) = .38, *p* = ns, *MSe* = .07, $\eta^2 p$= .01.

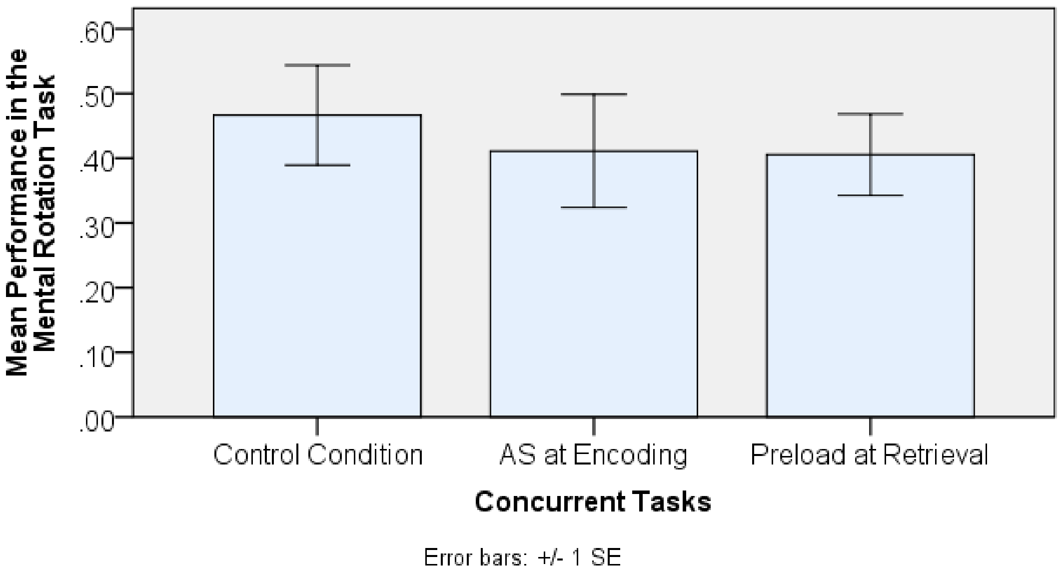


Figure 22. Performance in the rotation task in Experiment 3, expressed by the proportion correct score for participants in each condition.

Appendix E: Participant-based Analyses across Experiment 2 and 3

The proportionally corrected score for each participant was calculated using the same method of Experiments 2 and 3. See Figure 23 for the means of proportionally corrected scores in each condition. A 2 (method of presentation: temporal vs. spatial) x 3 (concurrent tasks: control, AS at encoding, and preload at retrieval) ANOVA between groups showed a marginally significant main effect of the concurrent tasks, F (2, 84) = 3.04, p = .053, *MSe* = .07, η^2p= .07. When collapsing across temporal and spatial presentation, performance in the control conditions (*M*= *.51*, *SD* = .16) was higher than performance on both AS at encoding condition (*M* = .35, *SD* = .8) and preload at retrieval (*M* = .4, *SD* = .13). No significant main effect was found for the method of presentation, F (1, 84) = .09, p = ns, *MSe* = .07, η^2p= .001. No significant interaction was found between the concurrent tasks and the method of presentation, F (2, 84) = 1.28, p = ns, *MSe* = .07, η^2p= .03.

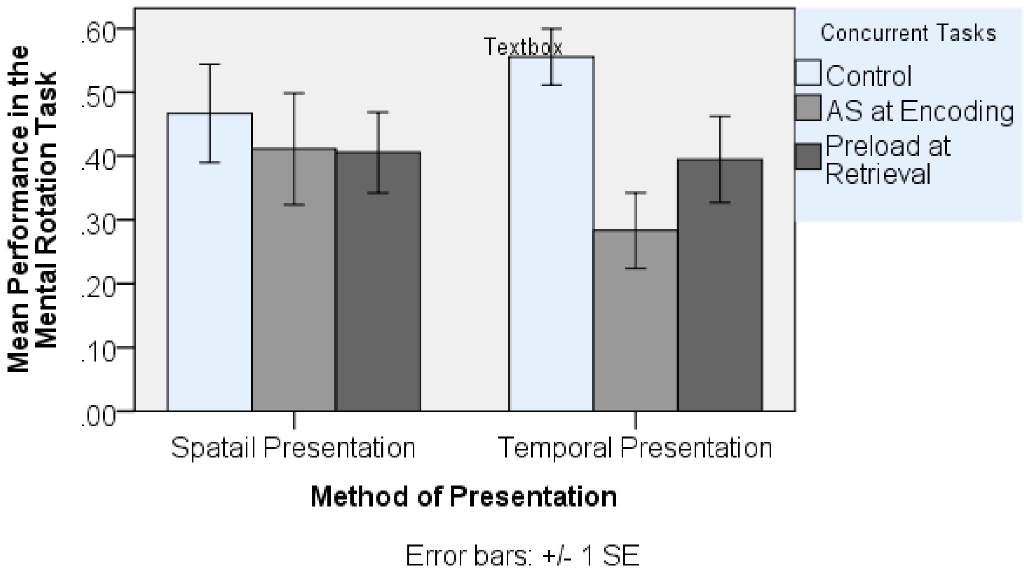


Figure 23. Performance in the rotation task across Experiments 2 and 3, expressed by the proportion correct score for participants in each condition.

A 2 (method of presentation) x 2 (concurrent tasks: control vs. AS at encoding) ANOVA between groups showed a significant main effect of AS at encoding, F (1, 56) = 5.626, $p < .05$, MSe = .07, $\eta^2 p$= .09. When collapsing across temporal and spatial presentation, performance in the control conditions (M= 51, SD = .24) was significantly higher than performance on AS at encoding condition (M = .35, SD = .29). No significant main effect was found for the method of presentation, F (1, 56) = .079, p = ns, MSe = .07, $\eta^2 p$= .001. No significant interaction was found between the concurrent tasks and the method of presentation, F (1, 56) = 2.46, p = ns, MSe = .07, $\eta^2 p$= .04.

A 2 (method of presentation) x 2 (concurrent tasks: control vs. preload at retrieval) ANOVA between groups showed a marginally significant main effect of the preload task, F (1, 56) = 3.001, p = .089, MSe = .06, $\eta^2 p$= .051. When collapsing across temporal and spatial presentation, performance in the control conditions (M= 51, SD = .24) was numerically higher than performance on preload at retrieval condition (M = .4, SD = .25). No significant main effect is found for the method of presentation, F (1, 56) = .368, p = ns, MSe = .06, $\eta^2 p$= .007. No significant interaction was found between the concurrent tasks and the method of presentation, F (1, 56) =.608, p = ns, MSe = .06, $\eta^2 p$= .011.

Appendix F: Participant-based Analyses for Experiment 4

As each participant was presented with six shapes, and each shape consisted of two letters, the maximum number of correct answers was 12. A proportion correct score was calculated for each participant by dividing the number of correct answers by the total number of possible answers. See Figure 24 for the means of proportion correct scores for each condition. A 2 (shape type: easy-to-name shapes vs. hard-to-name shapes) x 2 (label type: self-generated labels vs. control) ANOVA between groups revealed a significant main effect of the label type on participants' performance in the rotation task, F (1, 76) = 4.096, $p < .05$, $MSe = .05$, $\eta^2 p = .05$. Collapsing across both easy-to-name and hard-to-name shapes, performance in the control condition ($M = .35$, $SD = .23$) was higher than performance in the self-generated label condition ($M = .25$, $SD = .23$). The main effect of shape type was not significant F (1, 76) = .531, p = ns. There was no significant difference between performance on easy-to-name shapes ($M = .28$, $SD = .21$) and performance on hard-to-name shapes ($M = .32$, $SD = .25$). The effects of the self-generated labels did not interact with the shape type, F (1, 76) = .321, p = ns.

A one way ANOVA between easy-to-name control ($M = .35$, $SD = .19$) and easy-to-name self-generated labels ($M = .21$, $SD = .21$) revealed a main significant effect of self-generated labels, F (1, 38) = 4.28, $p < .05$, $MSe = .04$, $\eta^2 p = .1$. However, a one way ANOVA between hard-to-name control ($M = .36$, $SD = .26$) and hard-to-name self-generated label condition ($M = .28$, $SD = .25$) revealed no significant effect of self-generated labels, F (1, 38) =, 87, p = ns.

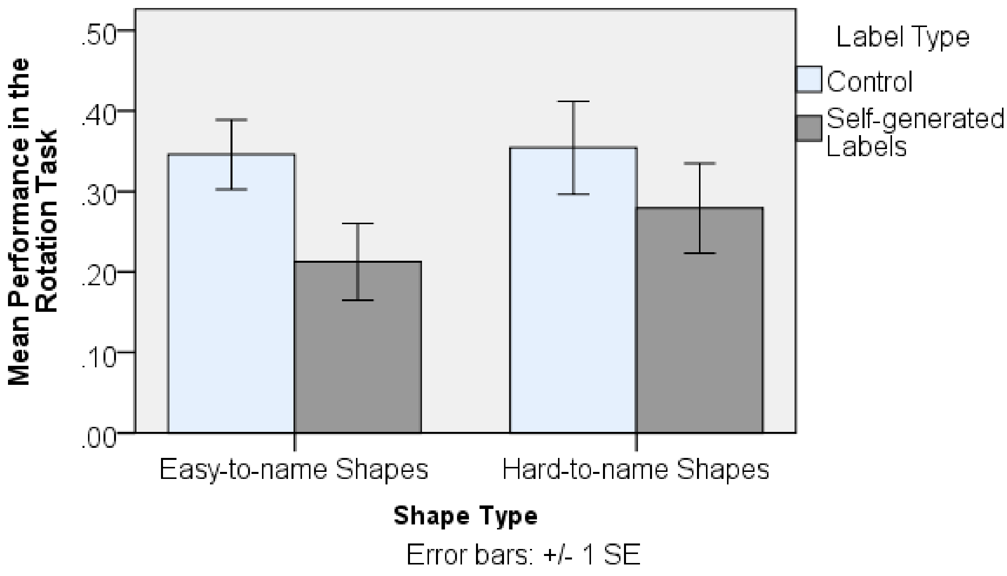


Figure 24. Performance in the rotation task in Experiment 4, expressed by the proportion correct score for participants in each condition.

Appendix G: Self-generated Labels by Participants and Ratings by Judges in Experiment 4

Table 7. Names by participants and ratings for easy-to-name shapes in Experiment 4.

Shape	*Names*	*Number of Participants*	*Rating Score*
AB	Ship	2	2.5
	Mask	11	4
	Glasses	1	2
	Boat	2	3
	Triangle	3	1.5
	A slide into a swimming pool	1	1.5
TL	Chair	17	4
	Square	2	1
EH	TV	1	2.5
	Stand	3	3
	Tree	1	2.5
	Lamp	3	4
	Rectangle	2	1
	Blackboard	2	2
	Flower	1	2
	Two squares	1	1

Shape	*Names*	*Number of Participants*	*Rating Score*
	Chair	1	3
	Double S	1	2.5
	Glass	1	2
	Desk	1	2
	Rectangle + square	1	1
	Stool	1	3
	Umbrella	11	4
	Semi-circle	4	2.5
	Semi-circle + rectangle	1	1
CH	Upside down boat	1	1.5
	Button	1	2.5
	A half cup	1	2
	HD	1	4
	Shade	1	2
	Book	10	3.5
	Bridge	3	3
	Window	2	3
EC	Parallel	1	1
	Tooth	1	2
	Stand for music	1	3
	Square + rectangle	1	1
CD	Brain	1	2.5

Shape	*Names*	*Number of Participants*	*Rating Score*
	Tablet	1	4
	Circle	8	4
	Ball	5	4
	A circle with a line in the middle	1	4
	Stop logo	1	4
	Semi-circles	1	4
	Circle with semi-circles	1	3.5
	Orange	1	2.5

Table 8. Names by participants and ratings for easy-to-name shapes in Experiment 4.

Shape	*Names*	*Number of Participants*	*Rating Score*
CS	Water drop	7	4
	Tear drop	5	4
	Whale	3	1.5
	Peacock feather	1	1.5
	Eye brow	1	2.5
	Moon	1	1
	Half of the yin yang	1	3
	Yin yang	1	1.5
AF	Wall	1	3
	Chair	1	1.5
	Triangle	2	2
	Sideways ‘z’	1	1.5
	House	1	2
	Roof	4	2.5
	Triangle + square	2	1
	Building	1	3.5
	Steps	1	1.5
	Cube	1	1
	Fence	1	1.5

Shape	*Names*	*Number of Participants*	*Rating Score*
	Drooping nose	1	1.5
	A	2	2
	AF	1	3.5
	Square	4	1.5
	Two squares	1	2
	Box	2	1.5
	Wall	2	1.5
	House	2	1.5
FI	Eraser	1	2.5
	Part of a square	2	1
	Rectangle	1	2
	F L	1	2
	E	1	1.5
	A	3	1.5
	Hat	3	3
	Half tent	1	2
	Circle	1	1.5
	Semi-circle	6	1
CZ	Dome	1	2
	Semi-circle + triangle	2	3
	CZ	2	3
	Army helmet	1	2.5

Shape	*Names*	*Number of Participants*	*Rating Score*
	Helmet	1	4
	Semi-circle	1	2
	Tortoise	1	2
	Two half circles	5	2.5
	Sideways ‘P’	1	1
	Eye	1	1
CP	Upside down semi-circle	1	1
	Cap	2	3.5
	Upside down cushion	1	1
	P	1	2
	Hat	1	3.5
	Crescent	1	1.5
	CP	1	4
	A	2	2.5
	S	2	3
	Jagged line	1	3
	V A	2	3.5
VA	Zigzag	3	2.5
	Triangle + zigzag	2	3.5
	Mountain	3	2
	Nose	1	1.5
	Z A	1	1

Shape	*Names*	*Number of Participants*	*Rating Score*
	Two triangles	3	1

Appendix H: Participant-based Analyses for Experiment 5

As each participant was presented with six shapes, and each shape consisted of two letters, the maximum number of correct answers was 12. We calculated a proportionally corrected score for each participant by dividing the number of correct answers by the total number of possible answers. See Figure 25 for the means of proportionally corrected scores for each condition. A 2 (label type: appropriate labels vs. nonwords) x 2 (cue type: cues vs. no cues) ANOVA between groups revealed a significant main effect of label type on participants performance in the rotation task, F (1, 76) = 4.55, $p < .05$, MSe = .06, $\eta^2 p$= .06. Performance in the appropriate label condition (M = .4, SD = .24) was higher than performance in the nonword condition (M = .29, SD = .23). The main effect of cueing was not significant F (1, 76) = 2.25, p = ns. There was no significant difference between performance on cueing conditions (M = .38, SD = .26) and performance on no cueing conditions (M = .3, SD =.22). The effects of label type did not interact with cueing, F (1, 76) = .03, p = ns.

It was suggested that presenting appropriate labels as cues at retrieval might show a larger positive effect on performance compared to nonword cues because appropriate labels were already matched with the shapes. However, a one way ANOVA between group design showed that performance in appropriate labels with cues (M = .44, SD = .26) was not significantly higher than performance on appropriate labels with no cues (M = .35, SD =.23), F (1, 38) = 1.29, p= ns, MSe = .06, $\eta^2 p$= .03. Additionally, performance in nonwords with cues (M = .32, SD = .25) was not significantly higher than performance on nonwords with no cues (M = .25, SD =.2), F (1, 38) = .97, p = ns, MSe = .05, $\eta^2 p$= .03.

A one way ANOVA between the control condition (*M* = .42, *SD* = .22), appropriate labels with no cues (*M* = .35, *SD* = .23) and nonwords with no cues (*M* = .25, *SD* = .2) revealed a marginally significant effect of label type, F (2, 57) = 3.12, p = .05, *MSe* = .05, $\eta^2 p$= .1.

Difference scores were explored by calculating the differences in the means between the control condition and each of appropriate labels with no cues and nonwords with no cues. A one way ANOVA did not show a significant main effect of the label type on the size of differences from the control condition, F (1, 38) = 1.1, p = ns. The size of differences from the control condition did not significantly differ for nonwords with no cues (*M* = .1, *SD* = .36) and appropriate labels with no cues (*M* = - .02, *SD* = .38).

A one way ANOVA between the control condition (*M* = .42, *SD* = .22), appropriate cues (*M* = .44, *SD* = .06) and nonwords cues (*M* = .32, *SD* = .06) revealed no significant effect of cue type, F (2, 57) = 1.404, p = ns, *MSe* = .06, $\eta^2 p$= .05. Difference scores were explored by calculating the differences in the means between the control condition and each of appropriate labels with cues and nonwords with cues. A one way ANOVA did not show a significant main effect of the label type on the size of differences from the control condition, F (1, 38) = 1.27, p = ns. The size of differences from the control condition did not significantly differ for nonwords with cues (*M* = .17, *SD* = .28) and appropriate labels with cues (*M* = .07, *SD* = .31).

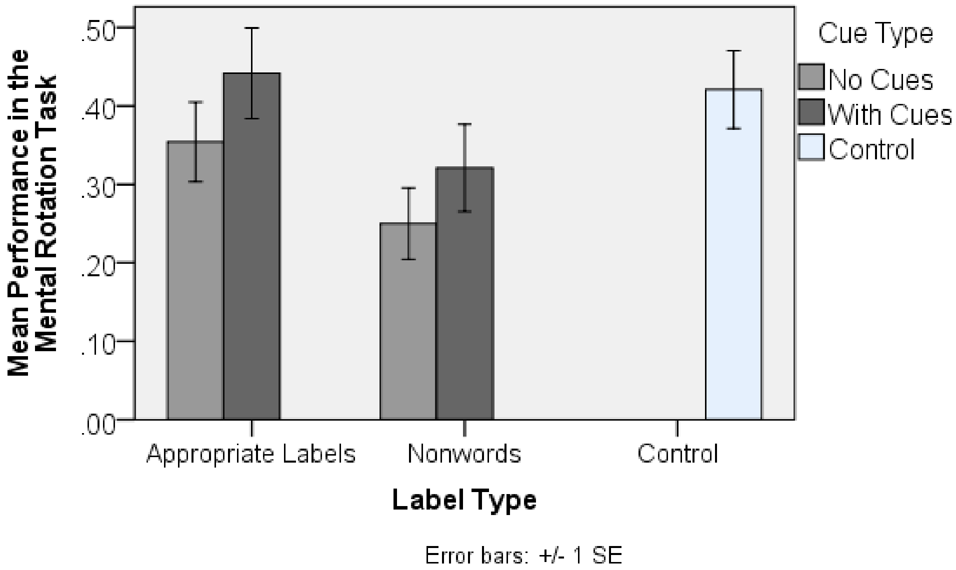


Figure 25. Performance in the rotation task in Experiment 5, expressed by the proportion correct score for participants in each condition.

Appendix I: Participant-based Analyses for Experiment 6

As each participant was presented with six shapes, and each shape consisted of two letters, the maximum number of correct answers was 12. We calculated a proportionally corrected score for each participant by dividing the number of correct answers by the total number of possible answers. See Figure 26 for the means of proportionally corrected scores for each condition. A 2 (label type: appropriate labels vs. nonwords) x 2 (labels at first presentation vs. labels at third presentation) analysis of variance (ANOVA) between groups revealed no significant main effect of label type on participants' performance in the rotation task, F (1,76) = .002, p = ns. Performance in the appropriate label condition (M = .31, SD = .24) did not differ from performance in the nonword condition (M = .31, SD = .21). The main effect of time of presentation of labels was not significant F (1, 76) = .94, p = ns. There was no significant difference between performance on labels at first presentation conditions (M = .34, SD = .24) and performance on labels at third presentation conditions (M = .3, SD =.2). The effects of label type did not interact with time of presentation of labels, F (1, 76) = 1.93, p = ns.

A one way ANOVA showed that the control condition (M = .33, SD = .27) was not significantly different from any of the labelling conditions, appropriate labels at first presentation (M = .3, SD = .26), appropriate labels at third presentation (M = .33, SD = .23), nonwords at first presentation (M = .37, SD = .23), and nonwords at third presentation (M = .25, SD = .17), F (1, 38) = .11, F (1, 38) = .01, F (1, 38) = .22, and F (1, 38) = 1.24, p = ns, respectively.

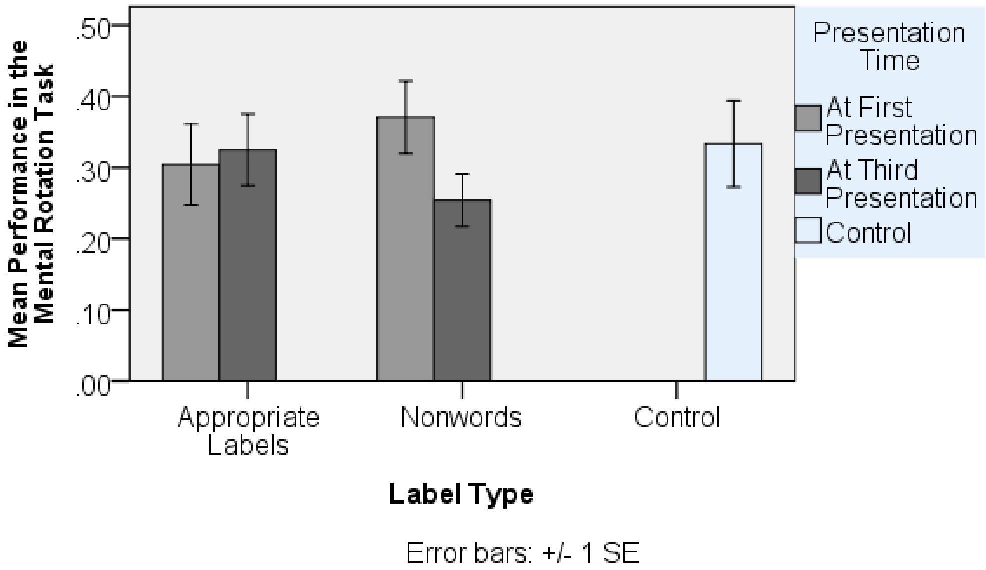


Figure 26. Performance in the rotation task in Experiment 6, expressed by the proportion correct score for participants in each condition.

Appendix J: Participant Based Analyses for Experiment 7

As each participant was presented with six shapes, and each shape consisted of one letter/number, the maximum number of correct answers was 6. A proportionally corrected score for each participant was calculated by dividing the number of correct answers by the total number of possible answers. See Figure 27 for the means of proportionally corrected scores for each condition. A 2 (shape type: easy-to-name shapes vs. hard-to-name shapes) x 2 (concurrent task: control vs. AS at encoding) ANOVA between groups revealed that there was a significant main effect of shape type on participants performance in the subtraction task, F (1, 96) = 4.01, $p < .05$, $MSe = .09$, $\eta^2 p = .04$. Performance in the easy-to-name shapes (M = .63, SD = .29) was higher than performance in the hard-to-name shapes (M = .51, SD = .33). The main effect of AS at encoding was significant F (1, 96) = 8.37, $p < .01$, $MSe = .09$, $\eta^2 p = .08$. Performance on AS at encoding condition (M = .48, SD = .3) was lower than performance on control conditions (M = .65, SD =.31). The effects of shape type did not interact with the effect of the concurrent task, F (1, 96) < .001, p = ns.

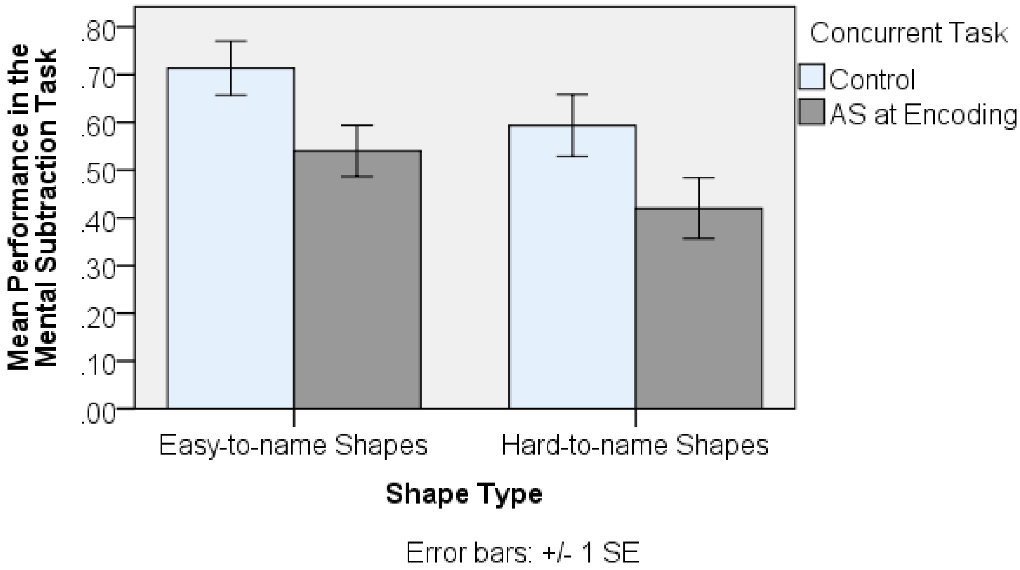


Figure 27. Performance in the subtraction task in Experiment 7, expressed by the proportion correct score for participants in each condition.

Appendix K: Participant-based Analyses for Experiment 8

As only six shapes were included in the analyses, and each shape consisted of one letter/number, the maximum number of correct answers was 6. Proportionally corrected score was calculated for each participant by dividing the number of correct answers by the total number of possible answers. See Figure 28 for the means of proportionally corrected scores for each condition. A 2 (label type: appropriate labels vs. nonwords) x 2 (cue type: cues vs. no cues) ANOVA between groups revealed a marginally significant main effect of label type on participants' performance in the subtraction task, F (1, 56) = 3.04, p = .087, MSe = .06, $\eta^2 p$= .05. Performance in the appropriate label condition (M = .42, SD = .29) was numerically higher than performance in the nonwords condition (M = .31, SD = .27). The main effect of cueing was significant F (1, 56) = 17.53, p < .001, MSe = .06, $\eta^2 p$= .24. Performance on cueing conditions (M = .49, SD = .3) was significantly higher than performance on no cueing conditions (M = .23, SD =.19). The effects of label type did not interact with cueing, F (1, 56) = .27, p = ns.

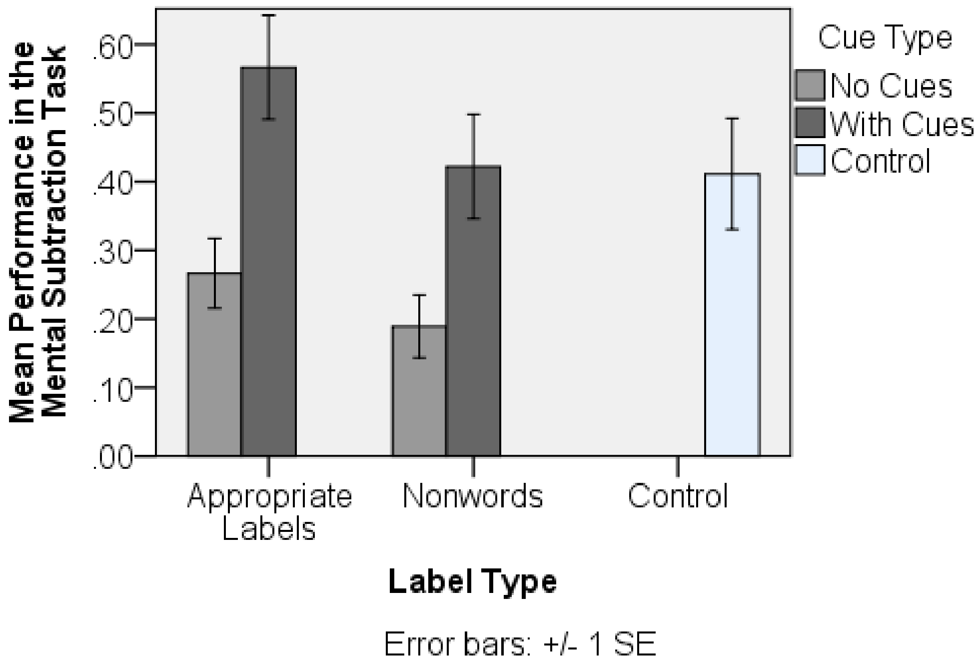


Figure 28. Performance in the subtraction task in Experiment 8, expressed by the proportion correct score for participants in each condition.

Further analyses of the effect of cueing by repeated measures ANOVA showed that performance in appropriate labels with cues (*M* = .57, *SD* = .29) was higher than performance on appropriate labels with no cues (*M* = .27, *SD* = .2), F (1, 28) = 10.77, $p < .01$, *MSe* = .06, η^2p= .28. Additionally, performance in nonwords with cues (*M* = .43, *SD* = .29) was higher than performance on nonwords with no cues (*M* = .19, *SD* = .18), F (1, 28) = 6.92, $p < .05$, *MSe* = .06, η^2p= .2.

A one way ANOVA between the control condition (*M* = .41, *SD* = .31) and appropriate labels with no cues (*M* =.27, *SD* = .2) and nonwords with no cues (*M* = .19, *SD* = .18) revealed a significant effect of label type, F (1, 42) = 3.39, $p < .05$, *MSe* = .06, η^2p= .14. Post hoc comparisons using the Tukey HSD test indicated that performance for the control condition (*M* = .41, *SD* = .31) was not significantly higher than appropriate labels with no cues condition (*M* = .27, *SD* = .2), *p* = ns. However, the control condition (*M* = .41, *SD* = .31) was significantly higher than nonwords with no cues condition (*M* = .19, *SD* = .18), $p < .05$. Finally, performance for appropriate labels with no cues condition (*M* = .27, *SD* = .2) was not significantly higher than nonwords with no cues condition (*M* = .19, *SD* = .18), *p* = ns.

Difference scores were explored by calculating the differences in the means between the control condition and each of appropriate labels with no cues and nonwords with no cues. A one way ANOVA did not show a significant main effect of the label type on the size of differences from the control condition, *F* (1, 28) = .33, *p* = ns. The size of difference from the control condition was not different for appropriate labels with no cues (*M* = .14, *SD* = .37) compared to nonwords with no cues (*M* = - .22, *SD* = .35).

A one way ANOVA between the control condition (*M* = .41, *SD* = .31), appropriate cues (*M* =.57, *SD* = .29) and nonwords cues (*M* = .42, *SD* = .29) revealed no significant effect of cue type, *F* (1, 42) = 1.25, *p* = ns.

Difference scores were explored by calculating the differences in the means between the control condition and each of appropriate labels with cues and nonwords with cues. A one way ANOVA showed no significant main effect of the label type on the size of differences from the control condition, *F* (1, 28) = .15, *p* = ns. The size of difference from the control condition was larger for appropriate labels with cues (*M* = .15, *SD* = .35) compared to nonwords with cues (*M* = - .01, *SD* = .48).

Analyses including all shapes. As there was one correct answer for each shape, participants' responses were scored as 0 when they gave an incorrect answer or 1 when they gave a correct answer. Within each condition participants responses were then pooled to provide a mean proportion correct score for each item. See Figure 29 for the mean proportion correct scores for each condition.

It was aimed to examine whether appropriate names would show better imagery performance compared to performance influenced by nonwords. A 2 (label type: appropriate labels vs. nonwords) x 2 (cue type: cues vs. no cues) repeated measures Analysis of Variance (ANOVA) revealed a significant main effect of label type on participants performance in the subtraction task, F (1, 9) = 9.97, $p < .01$, MSe = .02, η^2p= .53. Performance in the appropriate label condition (M = .48, SD = .2) was higher than performance in the nonwords condition (M = .36, SD = .16). The main effect of cueing was significant, F (1, 9) = 53.7, $p < .001$, MSe = .02, η^2p= .86. Performance on cueing conditions (M = .58, SD = .22) was significantly higher than performance on no cueing conditions (M = .26, SD =.14). The effects of label type did not interact with cueing, F (1, 9) = 1.77, p = ns.

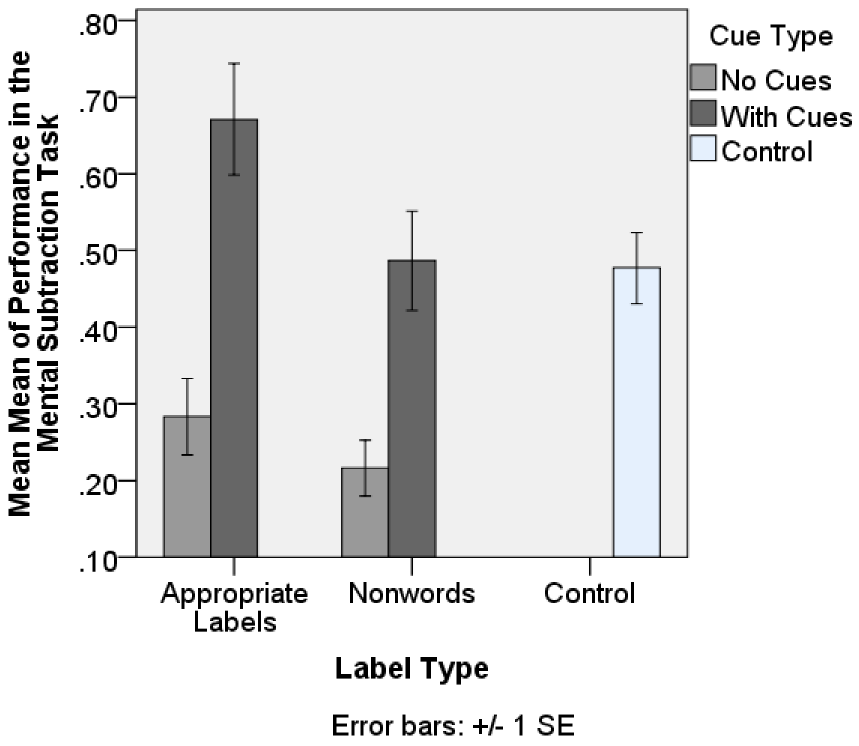


Figure 29. Performance in the subtraction task in Experiment 8, expressed by the proportion correct scores for items in each condition.

Additionally, it was aimed to examine the effect of experimenter-generated labels compared to spontaneous naming. A one way repeated measure ANOVA between the control condition, appropriate labels with no cues and nonwords with no cues revealed a significant effect of label type, F (2, 18) = 19.84, $p < .001$, MSe = .01, $\eta^2 p$= .69. Post hoc comparisons using the Tukey HSD test indicated that performance for the control condition (M = .48, SD = .15) was significantly higher than appropriate labels with no cues condition (M = .28, SD = .16), $p < .05$. Additionally, the control condition (M = .48, SD = .15) was significantly higher than nonwords with no cues condition (M = .22, SD = .11), $p < .01$. Finally, performance for appropriate labels with no cues condition (M = .28, SD = .16) was not significantly higher than the nonwords with no cues condition (M = .21, SD = .11), p = ns.

Furthermore, it was aimed to examine whether presenting labels as retrieval cues improved performance to the level of the control condition. A one way repeated measure ANOVA between the control condition, appropriate cues and nonword cues revealed a significant effect of cue type, F (2, 18) = 7.21, $p < .01$, MSe = .02, $\eta^2 p$= .45. Post hoc comparisons using the Tukey HSD test indicated that performance for the control condition (M = .48, SD = .15) was not significantly lower than appropriate labels with cues condition (M = .67, SD = .23), p = ns. Additionally, the control condition (M = .48, SD = .15) was not significantly lower than nonwords with cues condition (M = .49, SD = .2), p = ns. Finally, performance for appropriate labels with cues condition (M = .67, SD = .23) was not significantly higher than nonwords with cues condition (M = .49, SD = .2), p = ns.

Appendix L: Summary of Experiments

Table 9. Conditions and main findings from Experiment (1-8).

Experiment	*Paradigm*	*Main Findings*
1	Mental rotation paper-based paradigm 60 participants, assigned to 4 conditions, 15 each. Materials: 6 easy-to-name shapes Design: a 2 (temporal vs. spatial-temporal presentation method) x 2 (AS at encoding vs. control)	Interaction between effects of AS at encoding and presentation method (only by-items) AS at encoding showed impairment in temporal presentation condition (only by-items). AS at encoding did not show impairment in spatial-temporal presentation condition. Conclusion: spontaneous naming at encoding shows benefit with temporal presentation, but no benefit with spatial-presentation method.
2	Mental rotation computer-based paradigm, using the temporal presentation method 120 participants, assigned to 8 conditions, 15 each. Materials: 6 easy-to-name and 6 hard-to-name shapes Design: a 2 (easy-to-name vs. hard-to-name shapes) x 4 (control, AS at encoding, AS at retrieval, and preload at retrieval)	Performance was higher on easy-to-name compared to hard-to-name shapes. Negative effects of AS at encoding for both easy-to-name and hard-to-name shapes. Negative effects of AS and preload at retrieval for both easy-to-name and hard-to-name shapes (only by-items). Conclusion: Spontaneous naming occurs for both easy-to-name and hard-to-name shapes during encoding in temporal context. This benefits the memory task. Using the verbal code at retrieval benefits memory performance for both easy-to-name and. hard-to-name shapes.
3	Mental rotation computer-based paradigm, using the spatial presentation method 45 participants, assigned to 3 conditions, 15 each. Materials: 6 easy-to-name shapes Design: 3 conditions (control, AS at encoding, and preload at retrieval)	Concurrent verbal tasks did not show significant impairment compared to the control condition in this experiment.
2 and 3	90 participants: 45 from Experiment 2 and 45 from Experiment 3	Interaction between effects of AS at encoding and presentation method (only by-items)

Experiment	*Paradigm*	*Main Findings*
	Six conditions: 2 (temporal vs. spatial presentation method) x 3 (control, AS at encoding, and preload at retrieval)	Conclusion: spontaneous naming at encoding shows benefit with the temporal presentation, but no benefits with spatial-presentation method. Using the verbal code at retrieval shows benefit with the temporal presentation, but no benefits with the spatial presentation.
4	Mental rotation computer-based paradigm, using the temporal presentation method 80 participants, assigned to 4 conditions, 20 each. Materials: 6 easy-to-name and 6 hard-to-name shapes Design: a 2 (easy-to-name vs. hard-to-name shapes) x 2 (control vs. self-generated labels)	No significant difference between easy-to-name and hard-to-name shapes. Main effect of self-generated labels No interaction between label type and shape type, *F* = .32, but separate comparisons between self-generated labels and the control condition showed significant negative effects of labelling on easy-to-name but marginal impairing effects on hard-to-name shapes. Based on ratings of two judges, labels for easy-to-name are better matched with their shapes than labels for hard-to-name shapes Conclusion: Using explicit labels during encoding, contrary to using spontaneous names which benefit performance (Experiment 1-3), can impair memory for shapes.
5	Mental rotation computer-based paradigm, using the temporal presentation method 100 participants, assigned to 5 conditions, 20 each. Materials: 6 easy-to-name shapes Design: a 2 (appropriate labels vs. nonwords) x 2 (cues vs. no cues), in addition to a control condition (i. e., no labels or cues)	Main effect of label type: appropriate labels showed higher performance compared to nonwords. Nonwords labels impaired performance compared to spontaneous naming (the control condition) and appropriate labels showed lower performance than control condition but higher performance than nonwords. Main effect of cueing was found (but only in by-item analyses): Cues benefited performance compared to no cue conditions. Conclusion: Experimenter-generated labels can impair memory for shapes, and impairment increases when the label is not readily matched with the shape (i.e. with nonwords). Additionally, labels that are readily matched with their shapes show larger improvement in performance when presented as cues, compared to nonwords.
6	Mental rotation computer-based	No main effect for label type: Appropriate labels were not significantly different from

Experiment	*Paradigm*	*Main Findings*
	paradigm, using the temporal presentation method 100 participants, assigned to 5 conditions, 20 each. Materials: 6 easy-to-name shapes Design: a 2 (appropriate labels vs. nonwords) x 2 (labels at first presentation vs. labels at third presentation), in addition to a control condition (i. e., no labels or cues)	nonwords. Marginally significant effect for time of presentation (only by-items): Labels at third presentation showed trend toward lower performance compared to labels at first presentation. Interaction between label type and time of presentation (only by-item analysis). Nonwords at third presentation impaired performance compared to nonwords at first presentation. Nonwords at third presentation showed marginally significant lower performance than control condition (only by-items), while other labels were at same level as the control condition. Conclusion: Reducing the number of exposures to labels during encoding may prevent forming the picture-label associations and remove the interfering effect via explicit labels. Time-point when experimenter-generated labels are presented is important to determine the interfering effect of explicit labels.
7	Mental subtraction computer-based paradigm, using the temporal presentation method 100 participants, assigned to 4 conditions, 25 each. Materials: 6 easy-to-name and 6 hard-to-name shapes Design: a 2 (easy-to-name vs. hard-to-name shapes) x 2 (AS at encoding vs. control)	Performance on easy-to-name shapes was higher than performance on hard-to-name shapes (effect was only significant in analyses by-participants). Main effect of AS at encoding Conclusion: This finding replicates that from the mental rotation paradigm in showing a positive effect of spontaneous naming.
8	Mental subtraction computer-based paradigm, using the temporal presentation method 75 participants, assigned to 5 conditions, 15 each. Materials: 10 easy-to-name shapes, but only 6 shapes included in	Main effect of label type: appropriate labels showed marginally higher performance compared to nonwords. Nonwords and appropriate labels impaired performance compared to spontaneous covert naming in control, and nonwords producing greater impairment than appropriate labels. Main effect of cueing: Cues benefited performance compared to no cue

Experiment	*Paradigm*	*Main Findings*
	analyses Design: a 2 (appropriate labels vs. nonwords) x 2 (cues vs. no cues), in addition to a control condition (i. e., no labels or cues)	conditions, and showed a level of performance that was equivalent to the control condition. Conclusion: Findings replicate those from the mental rotation paradigm in showing an impairing effect by presenting experimenter-generated labels during encoding of shapes. Appropriate labels and non-words develop associations as performance can be improved using the experimenter-generated labels as cues.