Study on the dual code memory model

The dual code memory model proposes a verbal system for processing and storing linguistic information and a separate non verbal system for spatial information and mental imagery. Verbal information is largely associated with the left hemisphere and non verbal information is associated with the right hemisphere of the brain. These functions can function independently but are also interconnected. According to Paivio the images and words that have a high imagery rated concrete words centrally important in facilitating long term retention. Paivio [1971] termed the high imagery words as concrete and low imagery words as abstract. Paivio [1983] showed that our memory for pictures is superior to our memory for words This is called the picture superior effect, Paivio [1971] also showed that that our memory for high imagery concrete words is superior than low imagery abstract which is called the concreteness effect. The hypothesis of the study was that high imagery rated concrete words accompanied with pictures would be better remembered and recalled than both high imagery concrete words and low imagery abstract words presented separately. The words were chosen from the Toronto Word Pool. This was an independent sample experiment in which45 subjects participated. Independent variables were the stimuli that consisted of 20 high imagery concrete words, 20 low imagery words and 20 high imagery words accompanied with pictures. The dependent variable was the one minute time in which participants learned the words. An unrelated ANOVA was used. The results were significant to 0. 003 % and thus supported the hypothesis. The results suggest that high imagery words accompanied with pictures are better remembered than low imagery words. This can have implications in the field of education, advertisement and health awareness and communication. However, some factors need to be

taken into consideration for future experiments. These include age factor, spatial and recognition memory as well as recall, individual cognitive abilities, incidental learning instead of intentional learning to avoid subjects making memory strategies. Instructions regarding the experiment in respect to the order of learning the words need to be expressed more clearly to avoid subjects asking questions during the experiment; in line with this, participants need to be told to avoid communications with people during the experiment to ensure effectiveness.

According to the dual coding theory there are separate but interrelated verbal and non verbal [imaginal] coding systems both are of importance in learning and memory. In the words of Paivio [Eysenck 1998] ‘ the theory assumes that cognitive behaviour is mediated by two independent bur richly interconnected symbolic systems which are specialized for encoding, organizing, transforming, storing and retrieving information’. One [image system right hemispherical activity] is specialized for dealing with perceptual information concerning non verbal objects and events. The other verbal system [left hemispherical activity] is specialized for dealing with linguistic information [Paivio 1979]. Words with high imagery rating are considered concrete and words that have a low imagery rating are considered abstract [imagery and mind and its evolution]. According to Paivio [1971] both high imagery concrete and low imagery abstract words are processed by the verbal coding system, but high imagery concrete words can also be processed by the imaginal coding system, so it has the benefit of accessing both the right and left hemisphere instead of just the left hemisphere for low imagery abstract words. Paivio argues that the fact the high imagery

concrete words can be processed by two coding systems [verbal and imaginal] but abstract words are processed by only one coding system should give concrete words much better remembering than abstract words in tests of free recall, cued recall and recognition memory [Paivio 1971 in Eysenck 1998].

In one experiment Paivio and Csapo (1973 Maisto & Queen 1991), whilst investigating the additive effects of imaginal and verbal memory codes on recall, examined young adults' recall for pictures (P) and words (W) randomly distributed throughout a list. Repetition conditions, involving two successive presentations of an item were added to the lists. The repetition conditions consisted of picture (PP), word-word (WW), and picture-word or word-picture (PW). It was found that in standard free recall, PW repetitions significantly exceeded once-presented pictures (P), thereby confirming that " imaginal and verbal memory codes are independent and additive in their effect on recall"

Some evidence for the existence of separate verbal and imaginal coding systems was reported by Watkins [1984 in Eysenck 1998]. Their participants were presented with picture – word pairs [picture of an apple accompanied with the label apple] some of them were told to engage in verbal rehearsal, whereas others were told to try and maintain an image of the picture in your ' mind's eye' memory was then tested either by a word fragment completion task [- -ple] or by a picture fragment completion task. Verbal rehearsal improved performance on a word fragment task and imaginal rehearsal improved performance on the picture fragment task. These findings suggest that there may be separate verbal and imaginal coding systems and that

both may enhance long term memory in some circumstances [Eysenck 1998].

Nelson [197 in Eysenck 1998] put forward an alternative view to the dual coding hypothesis which he called the sensory – semantic model. According to this model, pictures produce better sensory codes than words. Pictures also differs form words in the way meaning in accessed; in order to access the name of the picture, it is necessary to process the meaning of the picture. However, the name of a word is available simply by processing its phonemic characteristics.

Paivio identified three levels at which information might be processed. The first was the representational level, where the sensory trace that was produced by an item when it was perceived arouses the appropriate symbolic representation in long term memory; thus words activate verbal representations [which Paivio called logogens] whereas as perceptual experiences and images activated imaginal representations [which he called imagens]. The second was the referential level, where symbolic representations in one system aroused corresponding representations in the other system; these interconnections were assumed to be involved in naming or describing objects, on the other hand, and in creating the image of an object when given its name, on the other hand. Finally, associative level involved associative connections among images, among verbal representations, or among both [imagery]. In learning and remembering all three levels were assumed potentially to be implicated. Consequently, performance could be based upon the image system, the verbal system or both. This was then linked to another assumption, the ‘ coding redundancy

hypothesis' this stated that memory performance increased directly with the number of alternative memory codes available for an item [Paivio 1971 p181 in imagery] ' because the items are increasingly likely to be stored in both the verbal and non verbal code. The increased availability of both codes increases the probability of item recall because the response can be retrieved form either code- one code could be forgotten during retention interval, but verbal recall would still be possible provided that the other is retained. Pictures and high imagery words, therefore, have both the verbal and imaginal codes [Paivio, 1971, in imagery].

The other major theory proposed to explain concreteness effects is the context availability model, which depicts comprehension as heavily reliant on contextual support provided by either the stimulus or the subject's own knowledge base . according to this theory, abstract words presented in isolation need this contextual support more than concrete ones because they are more vague and ambiguous and so more harder to process. Differences in the processing of both abstract and concrete words are not due to the operation of two processing systems [visual and verbal] such effects result from lack of built in contextual support present in the abstract stimuli. Therefore, in contrast to the dual coding theory context availability can be best described as a single code account for concreteness effect [Kounios J & Holcomb P 1994]. Whether concrete words are better remembered than abstract words is controversial as some psychologists replicated these experiments and found that intentional and incidental learning as well as other factors can affect the significance of the results [Marschark M & Surian L 1989].

Brain scan studies with normals have yielded information on the brain areas that are activated by dual coding variables in memory tasks. Brewer, Zhao, Desmond, Glovar, and Gabrielli [1998 in Paivio 2006] used FMRI to scan brain activity while participants studied pictures of everyday scenes, which they later tried to recognize from a new list. Brain activity was higher in both left and right posterior medial temporal lobes and in the right frontal lobe when participants studied pictures they later remembered as compared to pictures they later forgot. In contrast, using a similar procedure with words rather than pictures, Wagner, Schacter, Rotte, Kootstoal, Maril and Dale et al [1998] found that the brain activity when partcipants studied words they later remembered as compared to words they later forgot was greater in left hemisphere structures, specifically the posterior region of the left medial temporal lobe and in the left frontal lobe. The differential activation of right and left hemisphere areas for subsequently remembered pictures and words is consistent with previous research on DCT [Mind and its evolution]. Fliessbach K, Weis S, Klaver P, Elger C, & Weber B [2006 the effects of word concreteness on recognition memory]] investigated the processing of high imagery rated concrete words and low imagery abstract words during encoding and retrieval in a recognition memory task using even related functional magnetic resonance imaging [fMRI]. They found that memory performance was significantly better for concrete words than for abstract words.

Fliessbach K, Weis S, Klaver P, Elger C, & Weber B [2006 the effects of word concreteness on recognition memory] however, found brain activation in the

right and left hemisphere for high imagery concrete words which they conclude supports both the DCT and context availability theory.

In another study Whitehouse [1981 in Eysenck 1998] found that patients with anterior right hemisphere damage had better recognition memory for words than for pictures of namable objects, whereas left hemisphere patients did better with pictures than words. Whitehouse interpreted these and other findings from two experiments to be consistent with predictions from dual code theory. More detailed picture – word effects were reported by Stefan Kohler and his colleagues [Kohler, Moscovitch, Winacur, & McIntosh, 2000 in Eysenck 1998] who used PET to examine brain activity when participants studied and subsequently tried to recognize pictures of objects or their printed names. During the study the participants decided whether each of randomly presented items was a living or non living object. During recognition, the subjects made yes-no recognition judgments for a mixed sequences of studied items and new distracter items. The recognition items were presented in the studied format [picture-picture word-word or in a reverse format picture-word word picture. First the usual superiority effect of pictures over words in recognition memory occurred when pictures were presented both at encoding and during the recognition test. Second, as in previous studies, right medial temporal lobe [MTL] structures generally showed higher activation to pictures than words; in addition, two distinct regions in the left anterior and left posterior parahippocampal gyrus showed a differential picture response only at encoding. This means that some left [MTL] structures were co-activated with right MTL structures during picture processing. Kohler’s results are consistent with DCT in that distinct brain

areas were activated by pictures and words. The areas were predominately in the right hemisphere for pictures and in the left for words.

Support for the dual code theory also comes from several field of cognitive research. Villardita [1998 in Jessen F, Heun R, Erb M, Granath D, Klose U, Papassotiropoulos A & Grodd W in the concreteness effect 2000] demonstrated that patients with right hemisphere lesions performed significantly worse recalling previously studied high imagery nouns while a significant difference did not occur for the recollection of low imagery abstract words.

An explanation for the picture superiority effect can be understood by incidental redundant cues [in Childers and Housten 1984] and multiple retrieval paths. This explanation centers on the richness of the image in providing multiple cues that could save as aid to memory retrieval. When imaging a stimulus, a large number of incidental cues are contained within the image. For example, an image for a particular product might be of that product being used in a certain setting or activity. Incidental cues within the image might be background objects or clothes that one is wearing. This additional information is stored, retrieval paths are provided and memory is enhanced.

Stimulus differentiation and distinctiveness hypothesis argue that it is ability for the reader or observer to discriminate one stimulus from another at the time of encoding and that imagery promotes encoding [ibid] Nelson and Wailing in [ibid] attribute the picture superiority effect to encoding distinctiveness at the sensory level of processing. Marschark and Surian

[1992 in concreteness effect] also argue that high imagery rated concrete words are more likely than low imagery rated abstract words to be recalled because of the availability of associated perceptual information in the memory and that they would be more “ discriminable in memory and hence recalled better” Marschark and Surian [1992 in ibid] explain that low imagery rated abstract words are comprehended more poorly because persons take longer to retrieve readily available information associated with them, this finding also in support of the context availability theory in the explanation for memory for high imagery rated concrete and low imagery rated abstract words

Deep processing theory on the other hand argues that it is not the matter of pictures or words but more to do with how deeply the words were processed. John Anderson [1978 Eysenck 1998] suggested that “ theoretical reliance on picture word differences was fading because pictures are not necessarily remembered better if words are deeply encoded, he was alluding to an influential processing depth theory of memory proposed by Craik and Lockhart [1972]”. Relevant evidence emerged from an experiment by D’Agostino O’Neil and Paivio [1977] which contrasted predictions from a version of processing depth theory [Craik and Tulving 1975] and dual coding. The relevant contrast entailed verbal recall of pictures follow ‘ shallow’ coding and deep coding. Depth theory predicts superior recall under the sentence than the picture condition whereas dual coding does not because both conditions induce dual coding; however, results did not support deep processing hypothesis. One of the most influential theories of memory during the 1970s was proposed by Craik and Lockhart [1972 in Eysenck 1998] they

argued that the information that is stored in long term memory depends on the attentional and perceptual process occurring at the time of learning; more specifically they claimed that there are various different levels of processing. At the lowest level there is shallow processing of physical characteristics of stimuli, such as deciding whether the words are printed in capitals or lower case. At the highest level, there is deep processing, which involves processing the meaning of stimuli. According to Craik [1973] ‘ depth is defined in terms of meaningfulness extracted from the stimulus rather than in terms of numbers of analysis performed upon it. The key theoretical assumption made by Craik and Lockhart [1972] was that deep processing produces more elaborate, longer lasting and stronger memory traces than does shallow processing.

There is evidence to suggest in [ibid] that under certain conditions verbal only material is learned as readily as pictorial material. For example in the study of Lutz and Lutz [1971] interactive pictures, non interactive pictures and verbal counterparts were taken from advertisements in the Yellow Pages of telephone books and compared in terms of their impact on memory recall. Interactive pictures consisted of those in which the brand name and the product class were depicted in a visual format. Non interactive pictures consisted of either the brand shown in a visual format or the product class shown in a visual format while the control consisted of simply the brand-product -class verbal referents without any accompanying pictures. Only in the case of interactive pictures was the learning of pictures superior to words

Studies have shown that pictures, illustrations and high image concrete words have implications in the field of education [Ehri Deffner, and Wilce

1984 in Sadoski M & Paivio A; 2001] and in communication of health information [Brotherstone H, Miles A, Robb K, Atkin W, and Wardle J 2006]

A number of investigations have shown that training and instructions in the use of mental imagery can enhance memory performance in patients with diffuse cerebral damage as the result of stroke, head injuries, or Parkinson's disease in some studies, it was found that under imagery instructions both head injured patients and orthopaedic controls produced better retention on high imagery words than on low imagery words [Richardson & Barry 1985 in imagery]

Hypothesis and aims

The aims of this study is to see whether there is a significant difference in the memory recall for low imagery words, high imagery words and high imagery words accompanied with their pictures; the hypothesis of this study is that high imagery rated words accompanied with their pictures will be better remembered than low imagery rated words [discuss implications in introduction] due to studies on the picture superiority effect and high memorability for high imagery words performed by Paivio.

Method

Design

An independent samples experimental design was employed. Some reasons why this design was used in comparison to the repeated measures design is because in the latter, a there needed to be a significant waiting time between two conditions in order for the effects to be worn off from the participants to start the next test. The independent variables were the

stimuli that were, the high imagery rated words, low imagery rated words, and high imagery rated words presented with pictures and the dependent variables were how words the participants could remember in one minute

Participants

A sample of 45 participants were asked to take in this experiment although gender was not taken into consideration I was however, still noted. There were 19 female and 26 Male. Age was not asked from the participants. Participants were recruited from around East Lancashire Institute of High Education Blackburn and around Accrington. Only eight of the 45 participants were first year psychology and were tested in a controlled condition and were informed of the experiment well before by their tutor [see appendix for control], and the rest randomly from different places in Accrington. One participant was a third year psychology student. Literacy and education level or cultural differences were neither taken into any consideration in this study. 4 participants were selected from a retail shop in Accrington, 7 participants were selected from a silent reading of Accrington Library, 10 participants were from East Lancashire Institute of Higher Education, among which 4 were selected from the Canteen on the 7th floor during busy lunch hour, 3 were selected from higher education study centre in the library and book area [HESC] 16 participants were selected from various places along Blackburn Road during the busy traffic hours of 4: 30pm to 5: 00pm

Stimuli

20 High imagery words, 20 low imagery words, 20 high imagery words accompanied with pictures

Conditions

There were three conditions; one condition for memory recall for low imagery words, second condition was memory recall for high imagery words, and the third condition was memory recall high imagery words accompanied with pictures

Materials

20 low imagery words and 20 high imagery words were selected from the Toronto Word Pool [see appendix]. Words were chosen so that they were somewhat same in terms of concreteness and imageability. This was very important as Paivio had found that low imagery words, which he termed as Abstract, and high imagery words, which he termed as concrete were significantly important in terms of remembering, retaining and recalling. The mean for low imagery words 2. 8 and the mean for high imagery words was 6. 5 [see appendix] the highest imagery words and the lowest imagery words were taken from the Toronto Word Pool, a pool of 1, 080 words for which h normative ratings of imagery and concreteness exist. The low imagery words and high imagery words [see appendix] were computer typed, center aligned and the font Times New Romans, font size was 10, font type was bold and words were double lined spaced. The high imagery words with pictures [see appendix] were also Times New Roman, size 10 and bold, all the stimuli, the high imagery words, low imagery words, and high imagery words accompanied with pictures were presented on A4 paper. Pictures were selected from Microsoft Office [Vista] clip art collection and resized appropriately; size of the pictures was not measured to a particular measurement. Some graphical representations were actual photos whereas

others were drawn [see appendix]. The realness of the images was not considered, however it had to be a pictorial representation of the high imagery word written beneath it. Pictures were colour and were printed HESC laser colour printer. Colour pictures were use instead of black and white because a study by Childers and Houston 1984, in conditions for a picture superiority effect on consumer research found the effectiveness for memory for colored pictures in comparison to black and white pictures. A stop watch was used so that the participants could be timed accurately. All participants were briefed, consent taken and debriefed [see appendix] according to the British Psychological Society Code of Ethics. In the brief it was made sure that only the nature of the experiment is explained along with the instructions of what to do. In order to obtain more reliable results, and to eliminate recency effects in free recall a distraction task was also employed which involved reading a short poem written by William Shakespeare [see appendix] the poem was obtained from internet website via Google. There were not any specific preferences of how the distraction task should be like or what text could the participants read for distraction, neither there were any special preferences towards the layout or font of the distraction task.

Procedure

Firstly the participants were explained the nature of the experiment, their rights of confidentiality and withdrawal as well as instructions of what to do exactly how it is explained in the brief sheet. Participants were then given a consent form to read and sign. Participants were not told to remember to remember the words in any specific order neither they were told to only start reading the words when the experimenter has said so. The instruction to

stop as soon as one minute had ended was not given in the initial briefing. Before participants were given the stimulus the experimenter set the stop watch before hand. Participants then read the words for one minute. When time had ended the experimenter said ‘ you can stop reading now.’ Soon after the experiment the participants were given the passage written by Shakespeare and were told ‘ please can you read the passage’ [add in discussion] when the participants had read the passage they were provided with a A4 piece of lined paper together with a pen and were asked to recall the words they could remember [add in discussion, which words perhaps change the distraction ask?]. The recalling of the words was not timed [in the brief participants were not told that they had a fixed amount of time to recall the words]. When the participants said they had finished, results were taken off them and they were debriefed, in which they were told the aims and intentions of the experiment, purpose of the distracter task

Results and discussion

The result shows a significance of 0. 003 % significance and supports the hypothesis that pictures accompanied with high imagery words are better remembered than high imagery and low imagery words alone.

According to one study [Snodgrass and McCullough 1986 the role of visual similarity in picture categorization], visual similarity as a cue to category membership may produce the picture advantage. This is also called the visual similarity hypothesis. After analyzing the stimulus it was discovered that most pictures were also categorically related which can be questioned and experiment can be re evaluated. It was noticed that pictures that were presented to the participants contained 7 food and drink related pictures

that were lemon, water, salad, apple, sandwich, and coffee; 2 pictures were related to transport which were, police and engine, 3 pictures were related to buildings and contents which were castle, palace and window, two were related to places which were forest and island and needle, hammer, football, letter, jacket and baby were a single category. If Participants did categorize the pictures then this could affect the results of the experiment. There was visual similarity in the pictures in one instance but not so much in the words. For example, the word forest was accompanied with picture of trees and the island was also graphically represented with a tree. The tree for Island may have acted as cue for forest. These areas also need to be highlighted to gain more reliable results in future experiments. In one experiment conducted by Snodgrass [1948 in Snodgrass and McCullough 1986 the role of visual similarity]

The experiment that was constructed were of words listed down the middle of page and pictures set out on a paper accompanied with words; however, results may have been different the layout was different for example, a paragraph containing predominately high imagery words with low imagery words could be presented and participants told to read and then explain what they understood from the paragraph and the same can be done with another paragraph containing predominately low imagery words chosen from the Toronto Word Pool; these designs may yield different results. In this was comprehension would be measured instead of simple word recall. This is supported by an experiment conducted by Bunn, 1986 in Marschark & Surian 1989 in why does imagery improve memory] who found that when comprehensibility and structural variables are controlled [e. g. syntax and

macrostructure] are controlled concrete paragraphs do not yield concreteness effect. In line with this is another study conducted by Marschark and Surian 1992 [concreteness effects in free recall] found that concrete high imagery sentences were recalled better than abstract low imagery sentences when both were presented as randomly organized lists but the concreteness effect disappeared when the same sentence formed coherent paragraphs. This study suggests the significant different of results when concrete and abstract are presented together.

Subjects informed of the memory task would be more likely than those uninformed to use strategies intended to maximize recall. This would especially benefit concrete words because they readily suggest images. This brings the concept of incidental learning and intentional learning and thus how effective and reliable the results are. In one study [in imagery] it is argued that imagery instructions tend to enhance performance on high imagery materials, and instructions to motivate the subjects to learn can enhance performance on low imagery material [Sheehan, 1972 in imagery]. When instructions to learn are given participants reported to using imaginal mediators and method of loci for high imagery words. This was also found by Paivio and Yuille [1967 in imagery] who say ‘ another consideration is that subjects reports of their use of imaginal mediators increase in response to imagery instructions in a manner that is concomitant with the level of their recall performance [imagery]. In some studies motivational learning factors were not found to be highly significant rather, the semantic and emotional processing had come to light. Marschark and Surian [1992] also found of

participants engaging in memory strategies when in intentional learning and instructional conditions

The age factor and the emotional meaning of the words or pictures were not considered which could have been very significant. Some words may have been better recalled as they were emotionally arousing. The emotional significance of words also need to be considered to have a fuller understanding of memory recall. Kensinger & Corkin 2003 [in memory enhancement for emotional words] examined whether individuals were more likely to remember details of the presentation of negative words, as compared with neutral words. The experimenters found that the individual memories were more detailed for negative then for neutral words. In another experiment conducted by Mather & Nesmith 2008 [arousal enhanced location memory] participants were more likely to remember the locations of positive and negative arousing pictures than the locations of non arousing pictures

This study did not consider the age as a factor, which could have been very important to understand which age groups remembered and recalled words accompanied with pictures. Even though the results supported the hypothesis, pictures accompanied with words may not be helpful for older people. For example, One research conducted by Maisto & Queen [1991] compared the performance of younger (mean age — 20. 7 years) and older (mean age – 68. 3 years) adults on a memory task that involved pictures, words, and pictures-plus-words as stimuli. The results, consistent with previous research, indicated an equivalent picture superiority effect for both young and old adults when pictures were compared to words. More

specifically, although recall scores were significantly higher for younger adults compared to older adults, the superior recall scores for pictures versus words did not differ between the age groups. However, the performance of older adults declined markedly, compared to the younger adults, in the picture-plus-word condition Maisto & Queen 1991 concluded that ‘ These findings are interpreted as providing support for a divided attention model, which involves effortful processing of both visual and verbal aspects of stimuli.’ (Hasher & Zacks, 1979; Craik & Simon, 1980; Wright, 1981; Rabinowitz, Craik, & Ackernon, 1982 in Maisto & Queen 1991); therefore, unless age factor is not brought into the picture these results may not be generalized to all older adults.

Results with older adults, however, seem to be different with recognition and spatial memory in comparison to recall memory for example, in one experiment conducted by Park, Puglisi and Sovacool 1989 [in memory for pictures] gave young and old adults picture and words to study and were told to remember either just the item or the item and its location. Recogni