The Effects of Object Presentation Format on Memory and Confidence

Master Thesis Applied Cognitive Psychology

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Table of contents

Table of contents **2**

Abstract **3**

Introduction **4**

Method **8**

Participants **8**

Design **8**

Materials **8**

Procedure **9**

Results **10**

The effects of item display format on memory **10**

The effects of item display format on confidence **12**

Accuracy – confidence correlations **13**

The effects of remembering details on confidence **14**

The effects of a general theme on confidence **15**

Discussion **16**

References **19**

Appendix A **21**

Appendix B **23**

Abstract

The human memory is able to process different types of visual stimuli in different ways. In this study, objects were presented as words, drawings and photos. The effects of these formats on memory accuracy and confidence were examined, as well as the effects of a 3 week retention interval. The hypothesis that object format has an effect on memory accuracy and confidence was partly confirmed. In the immediate condition, both drawings and photos were better remembered than words, but there was no significant difference between drawings and photos, even though the photos contained more features. Confidence levels for drawings and photos did not differ as well. In the delay condition, the same pattern was found for accuracy, while the confidence levels did not differ for the object categories. The 3 week delay resulted in a significant decrease in accuracy and a decrease of the overall confidence-accuracy correlation to nearly 0, indicating overconfidence. For the drawings and photos separately, the correlation was high, but only if the participants were immediately tested. The results showed that if the retention interval is low, graphical stimuli can be accurately remembered and high confidence about graphical stimuli can be a good indicator of memory accuracy.

Introduction

Visual object recognition is one of the most important functions of the human brain. The visual system must recognize objects that have multiple features such as form, colour, texture or characteristic motion. The visual systems combines these to elaborate object representations. Objects must be recognized in different places, from many different vantage points and even when they are partially obstructed from view (Regan, 2000).

The ability to recall an experience at some later time requires information to be encoded, stored and retrieved. The human memory is able to store, retain and retrieve information, but it isn't flawless. Memories of events can be forgotten or distorted, so that the desired information is unavailable. Memory for facts and events typically become less accessible over time. Gradual forgetting (transience) can occur when a fact or event is well coded and remembered immediately, and even when a deliberate search in memory is performed to recall specific facts or events. Another reason is described as absent-mindedness. If insufficient information is devoted to a stimulus at the time of encoding or retrieval, it is possible that the information will be forgotten. But even when facts or events have been coded deeply and they haven't been lost over time, they may temporarily be inaccessible. If humans are provided with cues that are related to an item, but are unable to elicit it, a retrieval block has occurred (Schacter, 1999).

Memories of facts and events can be altered as well. Loftus (2003) describes various methods in which people can be talked into memories that have never happened. The key elements in planting false memories is that first, an event (that did not happen) has to be suggested to a person. Second, that person has to imagine that the event did happen. With some of the used methods, in up to 50% of the exposed individuals false memories have been planted. Individuals that have complete false memories can feel confident, provide details and express emotions about made-up events that have never happened. Another example is the situation in which some form of memory can be present, but misattributed to an incorrect time, place or person. If people watch an object, they rely on their memory for the general semantic features of the object. Memory encoding and retrieval are highly dependent on current knowledge, beliefs and expectations. Memories of past experiences can be altered and present knowledge and beliefs can be biased due to recollection of previous experiences (Schacter, 1999).

Various types of visual stimuli that may enhance or distort memory have been studied. Visual stimuli that are moving are better remembered (Noice & Noice, 2001). Negative advertisements or negative visually arousing objects are better remembered, and with a greater amount of details. The amygdala performs a primary role in the processing and memory of emotions. Consequently, a greater activity in some of the amygdala regions correlates to a better memory for details (Bradley, Angelini & Lee, 2007; Kensinger, Garoff-Eaton & Schacter, 2007). The “consistency effect” refers to the finding that visual stimuli inconsistent with expectations are better remembered than visual stimuli consistent with expectations (Pezdek, Whetstone, Reynolds, Askari & Dougherty, 1989). Different types of objects seem to affect memory accuracy as well. Line drawings of faces and cars, and photos of real faces and real cars were presented, and for both line drawings and photos, the faces were better remembered than the cars (Mckelvie, Standing, St. Jean & Law, 1993). In a similar experiment, faces and objects were compared and similar results were gained (Dobson & Rust, 1994).

Much research has been done about differences between words and graphical stimuli in memorization. According to most research, graphical stimuli are better remembered than words, either in drawing format (Haber & Myers, 1982) or in photo format (Rajaram & Roediger, 1993). The dual coding theory states that humans are redundantly encoding graphical images, because they evoke both verbal and non-verbal codes, whereas words only evoke verbal codes (Paivio, 1986). A neurological study by Grady, McIntosh, Rajah and Craik (1998) confirmed this theory. They examined brain activity while words and photos of objects were being encoded. Encoding of words was associated with regions related to language functions, while encoding of photos resulted in a greater activity in regions related to visual memory. Each encoding strategy had the same activity pattern. So while the encoding strategies are the same, photos may be better remembered than words because they are mediated by more effective areas that are important for visual memory.

Research about the effects of different types of graphical stimuli (such as line drawings and photos) on memory accuracy is not as unanimous. Drawings may be better remembered, because they contain only the gist of an object. On the other hand, photos may be easier recognized and memorized because they are (nearly) similar to real objects. Some studies concluded that several object features such as color, contrast and depth have an effect on visual recognition of memory, which could indicate that photos can be memorized more accurately. In a study by Suzuki and Takahashi (1997), photos were presented of which half were black and white, and the other half in color. In the immediate and 1 week retention interval recognition tests, the color photos were better remembered. But the results of the recall test were not as good. They concluded that the effectiveness was not due to the color in the photos themselves, but due to the distinctiveness of features highlighted by the colors. In a face recognition experiment by Leder (1996), any of the faces were displayed both as line drawings and as photos. Some of the faces contained more distinctive stimuli. When they were shown in photo format, they were better recognized than in line drawing format. These studies suggest that the more features a visual stimuli has, the better it can be remembered, which means that photos can be better remembered than drawings, and drawings can be better remembered than words.

As previously pointed out, memories of visual stimuli can fade because of gradual forgetting or other memory distortions (Schacter, 1999), which is supported by research. In a study by Park, Royal, Dudley and Morrell (1988), photos were presented and the recognition of the photos was tested at 5 intervals: immediately, and 48 hours, 1 week, 2 weeks and 4 weeks later. The results showed a steady decline in recognition over the weeks. The same decline in recognition could be expected if participants are tested after 3 weeks for words, drawings and photos.

People can remember seeing an object or other people, but to others (or to themselves) the accuracy of that memory can be doubtful. Eyewitnesses can be unsure of what they have seen a few days ago. In an attempt to determine the accuracy of memory, various methods have been examined, of which some were better than others. One method is to measure the confidence about a memory. Much research has been done about the correlation between confidence and accuracy. Results range from no correlations (Leippe, 1980; Smith, Kassin & Ellsworth, 1989) to substantial correlations (Sporer, 1993; Lindsay, Read & Sharma, 1998).

According to Busey, Tunnicliff, Loftus and Loftus (2000), confidence and accuracy seem to be related in face recognition. They measured the effects of the degree of rehearsal, study duration and luminance on recognizing faces. Confidence appeared to be a good indicator of accuracy, except when lumination was used. When the visual stimuli were well luminated, the participants tended to be more confident about the memory of the stimuli, due to the idea that the bright stimuli were more accurate. Most studies in which no confidence-accuracy correlations were found, attribute this to overconfidence. Another variable that may induce overconfidence is familiarity. Familiarity with a general theme can give people the illusion that they accurately remember details (Chandler, 1994). Participants were shown photos of a natural scene (for example, lake A). Later, the participants were shown 2 photos (lake A and lake C) and the participants had to choose which one they previously saw and rate the confidence in their choice. When the participants studied a related photo (lake B), their accuracy often decreased while their confidence increased. When a particular test was to be performed twice, the confidence level in the second test increased for both correct and incorrect answers. Retesting resulted in an increased overconfidence (Granhag, Stromwall, Allwood, 2000). In a face recognition experiment, participants were tested either in a (two alternative) forced choice procedure or in a yes/no procedure. The participants tested in the forced choice procedure were significantly more confident than participants tested in the yes/no procedure (Deffenbacher, Leu, & Brown, 1981).

Most of the studies stress that confidence-accuracy correlations only emerge in specific situations, if any is found. Accuracy and confidence depend partly on the participants ability to recognize stimuli (Lindsay et al., 1998). The conditions in which stimuli have to be remembered affect both accuracy and confidence. They tend to be higher under conditions that lead to good memory of the stimuli than under conditions that lead to poor memory of the stimuli. Manipulations that affected accuracy also affected confidence in the same direction, so they concluded that there is a substantial accuracy-confidence correlation.

The effects of a delay on confidence may be similar to the effects on memory accuracy, if confidence-accuracy correlations are strong. Recall experiments in which the testing procedure is either immediately or after several weeks, show that after several weeks both accuracy and confidence are significantly lower (Turtle & Yuille, 1994; Odinot & Wolters, 2006). Because of an expected decrease in accuracy, the confidence level are expected to decrease as well.

In this study, the effects of object display in word, drawing and photo form on memory accuracy were examined. Several studies have shown that stimuli with more features were better remembered. If this is caused by the amount of features, memory accuracy rates were expected to be in the order: photos > drawings > words. If confidence is based on the amount of stimuli remembered, confidence ratings should be higher in categories with more features. As with the memory accuracy rates, the confidence ratings were expected to be in the same order: photos > drawings > words. A 3 week interval was expected to cause both accuracy rates and confidence ratings to decline, but have the 3 category rates in the same order. If confidence is an indicator for an accurate memory, the confidence-accuracy correlation should at least be substantial (0.5 or higher) and be little affected by the 3 week retention interval.

Method

Participants

A total of 40 participants have participated (18 male and 22 female). All participants were volunteers, ages ranging from 18 years to 47 years and most were students at Leiden University. The only requirement for participants was the ability to speak Dutch, because the experiment was in Dutch.

Design

The participants were randomly assigned into 2 groups. The first group was assigned to the "immediate condition"; the participants were tested directly after they saw the items. The second group was assigned to the "delay condition"; these participants were tested 3 weeks after they saw the items. All participants were shown 90 objects (items), that were divided into 3 categories: words, drawings and photos.

Materials

Stimuli were selected from the set of drawings of Snodgrass and Vanderwart (1980). In total 180 drawings were selected of simple everyday objects. Half of these were used in the presentation phase, the other half as used as distractors in a subsequent recognition test. Of all drawings, corresponding words and photos (taken from internet sites) were determined. E-prime was used to display the 90 items on a computer screen in the presentation phase. The 90 items consisted of 30 printed words, 30 standardized Snodgrass black-and-white line drawings and 30 colour photos (Figure 1).

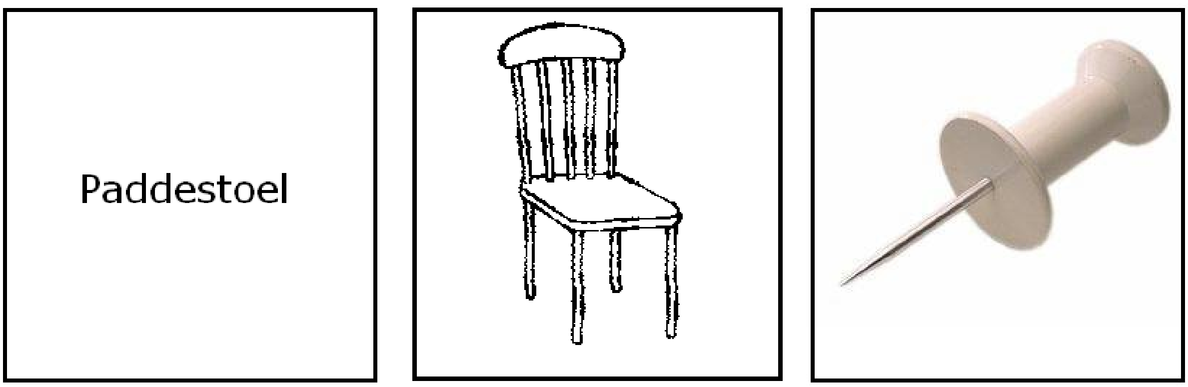

Figure 1. Samples of a printed word (left), black-and-white line drawing (center) and colour photo (right) as shown in the experiment.

In the second task, a DOS-game called “Pacman” was used. In the third task, a paper-and-pencil recognition test was used. In the recognition test all 180 stimuli were presented as written words.

Procedure

The experiment consisted of three parts. The first two parts were done by a computer, the last part was a recognition test. In the first part, the participants were shown 90 different items on a computer screen, of which 30 were shown as words, 30 were shown as drawings and another 30 were shown as photos. The Snodgrass drawings were selected for simplicity and general familiarity with participants, and they have unambiguous verbal labels, so participants would immediately be able to apply one specific label to the item. The photos corresponded closely to the drawings and had the object clearly centred, so participants would focus on the object. The 90 items were shown one at a time, and each item was shown once for 2,5 seconds. The items were shown in random order to control for a primacy and recency effect. In total the first part had a duration of approximately 5 minutes. The participants were instructed to memorise as many of the items as possible.

In the second task the participants had to play a game called “Pacman” for 15 minutes. This task was meant as a distraction. The only purpose was to prevent the participants from rehearsing the items from the previous task. This game had very little text and objects, so it would not help them rehearse the items.

In the third task, the participants did a recognition task in the form of a paper-and-pencil questionnaire. Half of the participants (of the immediate condition) had to fill it out directly after the previous two tasks, while the other half (of the delay condition) had to fill it out after 3 weeks. This questionnaire consisted of a list of 180 words. It had 90 new words (distractors, which the participants had not previously seen in the first task) and 90 old words that corresponded to the 90 items they had previously seen in the first task (in word, drawing or photo format). With each of the 180 words, there were 3 sections to be filled out by the participants. In the first section they had to indicate if this was a new word or an old word. In the second section they had to indicate how well they remembered seeing that item. Participants could choose from 3 answers: A) I do not remember that item - B) I remember the item superficially - C) I remember the item in detail. In the third section they had to indicate how confident they were of remembering (or not remembering) the item on a 7 point scale, in which “1” meant the lowest level of confidence, and “7” meant the highest level of confidence.

Results

In the analyses, the results of the recognition test of 39 participants have been used. The test results of 1 participant were discarded, because after the experiment, she stated that she misunderstood the instructions. The recognition test showed that it was very likely that she did (answers were randomly marked).

The effects of item display format on memory

To examine if the format in which words were presented originally (as word, drawing or photo) influenced memory, we determined the number of "hits" for the words, drawing and photo category. When a participant correctly marked an old item as an "old word", it was considered a "hit". When a participant incorrectly marked a "new item" as an "old word", it was considered a "false alarm". In order to obtain a fair representation of what items were correctly remembered, both hits and false alarms were determined. If only the hits had been determined, it could lead to a flawed result (even possibly resulting in a 100% hit rate, if a participant would use a lenient criterion). The number of false alarms was divided by 3 (because 3 times more new words have been used) and subtracted from the number of hits. An overview of the performance for each participant is displayed in Appendix A.

In a repeated measures MANOVA, performance in the words, drawings and photos categories showed a significant difference (F (2, 74)= 51.60, $p < 0.001$). So the presentation format indeed does have an influence on how well that object is remembered. To interpret this effect, the 3 item categories were also mutually compared. A significant difference was found when the words category was compared to both drawings category (F (1,37)= 69.88, $p < 0.001$) and photos category (F (1,37)= 56.11, $p < 0.001$). No significant difference was found between the drawings category and photos category.

The immediate and delay condition group were separately examined as well. A comparison between these two groups showed a significant difference (F (1, 37)= 215.22, $p < 0.001$). Performance in the delay condition clearly deteriorated in all item categories. The corrected hit rates for both conditions are shown in Table 1. The average number of hits in the immediate group shows that graphical stimuli were better remembered than verbal stimuli. While the graph in Figure 2 shows an increasing line, the difference between drawings and photos was not significant. The proportion of "correct rejected" items (new items correctly marked as "new word") from the distractors category (0.86) was as high as the proportion of hit items (uncorrected) from the drawings (0.82) and photos (0.87) categories.

In the delay group, the participants had a distinctive lower number of hits. A near 0 hit rate indicates that there were nearly as much false alarms as hits. In the words category the average hit rate was *M* = -0.18. The negative number indicates that there were more incorrect (43.7% false alarms) than correct answers (43.0% hits). The average number of "missed signals" (old items incorrectly marked as new words) was higher than the average number of hits (uncorrected) as well. In both graphical stimuli categories, performance was somewhat better. While the highest performance was in the drawings category, it did not significantly differ from the photo category. Little more than half of the items (56.3%) from the distractors category were correctly rejected.

Table 1. Average corrected number of hits. The number of hits have been corrected for false alarms (number of hits – ⅓ of number of false alarms).

Condition	**Words** (*N* = 30)	**Drawings** (*N* = 30)	**Photos** (*N* = 30)
Immediate (*N* = 19)	14.90	20.53	21.84
Delay (*N* = 20)	-0.18	6.72	4.32
Proportion hits in immediate condition	0.50	0.68	0.73
Proportion hits in delay condition	0.00	0.22	0.14

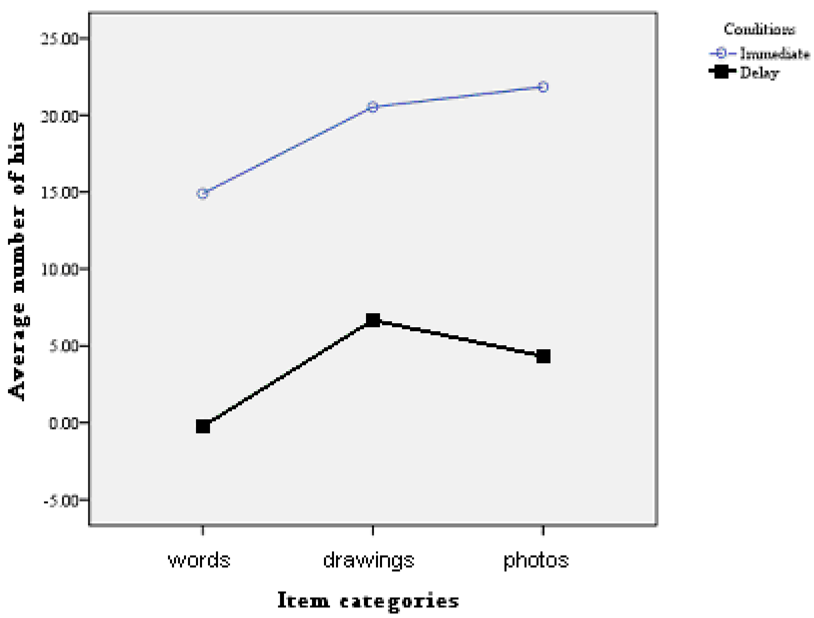

Figure 2. The average number of hits from the item categories.

The effects of item display format on confidence

The effects of the item's display format on the confidence of remembering that item were examined. For all of the 180 words on the recognition test, participants had to indicate how confident they were of remembering it (if they did remember it). For the hit items, the average confidence levels were determined (shown in Table 2). The confidence level was marked on a 1 (lowest confidence rating) – 7 (highest confidence rating) point scale. A repeated measures MANOVA showed a significant difference (F (2,74)= 19.97, $p < 0.01$) between the item categories. Confidence for words was significantly lower than for drawings and for photos, but there was no significant difference between drawings and photos. A 3 week delay clearly reduced confidence (F (1,37)= 47.72, $p < 0.01$). In the delay condition, the confidence level for all 3 categories was not significantly different (Figure 3). The participants had the same amount of confidence of the items, regardless of the item format. An overview of the confidence levels for each participant separately can be found in Appendix B.

Table 2. Average confidence levels for hit items.

Condition	**Words** (N = 30)	**Drawings** (N = 30)	**Photos** (N = 30)
Immediate (N = 19)	5.86	6.28	6.45
Delay (N = 20)	4.37	4.61	4.58

Note: Each category has a rating between 1 (lowest rating) – 7 (highest rating).

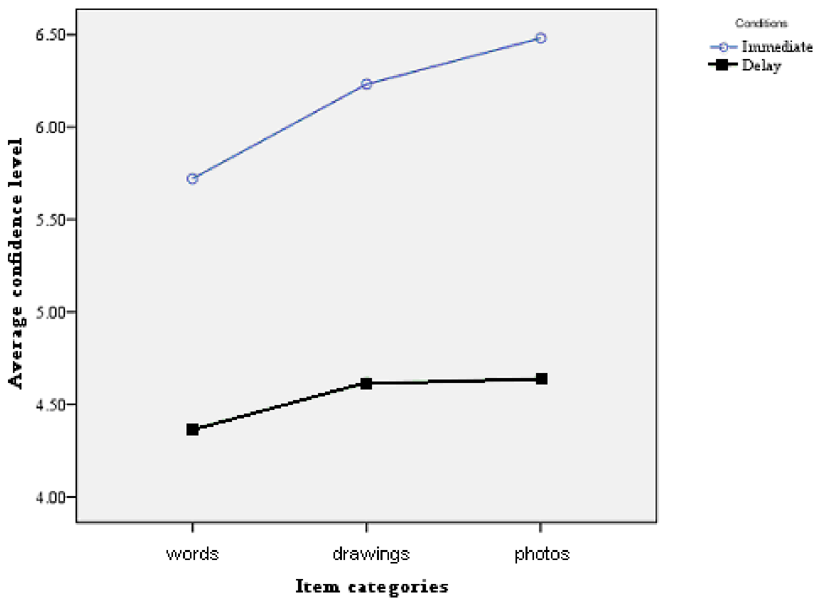

Figure 3. The confidence levels from the item categories.

An analysis of the confidence levels for missed signal items showed some different results. In the immediate condition (Table 3), confidence for words did not significantly differ from confidence for drawings or photos, but confidence for drawings was significantly lower than confidence for photos (F (1,35)= 11.09, $p < 0.01$). No interaction effects were found between the confidence for missed signal items and delay. In the delay condition, no significant differences were found between the 3 item categories.

The confidence levels of the correct rejected and false alarm items of the distractors category were examined as well. No significant differences were found and no interaction effects were found for delay. Participants showed the same level of confidence for correct and incorrect answered distractor items. The confidence level for new items that were correctly marked as "new" was not significantly different from new items that were incorrectly marked as "old".

Table 3. Average confidence levels for missed signal items.

Condition	**Words** (*N* = 30)	**Drawings** (*N* = 30)	**Photos** (*N* = 30)
Immediate (*N* = 19)	4.57	4.52	4.91
Delay (*N* = 20)	3.98	3.70	4.00

Note: Each category has a rating between 1 (lowest rating) – 7 (highest rating).

Accuracy – confidence correlations

The Goodman-Kruskal gamma was used to examine the correlation between accuracy and confidence. The Goodman-Kruskal gamma is a measure of association for ordinal level data, ranging from -1 to +1. An absolute value of 1 would indicate a perfect relationship, while 0 would be a perfect "non-relationship". The number of words that were correctly and incorrectly marked were determined for each of the 7 confidence levels (the 1- 7 point scale of confidence of the recognition test). The overall gamma correlation in the immediate condition was $\gamma = 0.46$ (*Min* = 0.03 ; *Max*. = 0.78) and in the delay condition $\gamma = 0.11$ (*Min* = -0.22 ; *Max*. = 0.37). The results show that a 3 week delay strongly decreased the accuracy-confidence correlation. Participants that accurately remembered a stimulus, were little more confident about it than when they inaccurately remembered a stimulus. Separate correlations for the 3 item categories showed higher correlations (Table 4).

Table 4. Goodman-Kruskal gamma correlations.

Condition	**Words** (*N* = 30)	**Drawings** (*N* = 30)	**Photos** (*N* = 30)
Immediate (*N* = 19)	0.54	0.73	0.75
Delay (*N* = 20)	0.21	0.44	0.34

In the immediate condition, the gamma correlation was substantial for verbal stimuli. For graphical stimuli, the gamma correlation was high. The results suggest that whitin item-types, confidence is a good indicator of accuracy, the participants were more confident about accurately remembered stimuli than about inaccurately remembered stimuli. In the delay condition however, correlations were lower. While confidence about drawings was the best indicator of accuracy, it is still rather weak.

Given the proposed hypothesis, over categories, accuracy-confidence correlations were expected to be higher than within-categories, but the opposite was found. The results seem to suggest that participants remember the original format of stimuli in the recognition task, and that they find it easier to distinguish accurate from inaccurate items within than between categories (and adapt their confidence ratings accordingly).

The effects of remembering details on confidence

For all 180 words in the recognition test, participants had to indicate whether or not they remembered them (either superficially or in detail) and how confident they were about remembering details of the originally presented item. The confidence level was marked on a 1– 7 point scale.

The degree of detail with which items were remembered (superficially or detailed and correctly remembered items only) was significantly related to confidence, as shown by a repeated measures MANOVA (F (1,37)= 202.29, $p < 0.01$). Items that were remembered in detail were more confidently remembered than items that were superficially remembered (Table 5).

Table 5. Average confidence levels of items as a function of the amount of remembered details and delay.

Condition	**Remembering superficially**	**Remembering in detail**
Immediate (*N* = 19)	4.23	6.65
Delay (*N* = 20)	4.13	6.25

Note: Each category has a rating between 1 (lowest rating) – 7 (highest rating).

By comparing the immediate condition group to the delay condition group, it shows that the confidence ratings do not differ much. The rating of the immediate condition group were slightly higher, but there was no significant difference between the groups. Unlike the decreasing accuracy-confidence correlations and the decreased accuracy, a 3 week delay did not influence the effects of the amount of remembered details on confidence. The results suggest that when the participants of the immediate condition were asked to rate their confidence, they used the same criteria as the participants in the delay condition.

The effects of a general theme on confidence

A part of the items that were presented could be categorized into a general theme. To examine (post-hoc) if confidence was higher for items that belong to a theme, 10 items that belonged to a theme (animals) from the drawings and photos categories were compared to 10 items that did not belong to a theme, also from the drawings and photos categories. Items from the words category were excluded, because previous analyses indicated that confidence for words was significantly lower. Confidence for 'theme' items did not significantly differ from 'non-theme' items. These items were also compared to 'non-theme' items from the distractors category, and significant differences were found (F (1,37)= 51.90, $p < 0.001$) and for delay as well (F (1,37)= 23.07, $p < 0.001$). The results suggest that the items that could be categorized into a general theme did not increase confidence for those items, or that participants did not attempt to categorize the items.

Discussion

In this study, the effects of object display format on memory accuracy and confidence were examined, as well as the effects of a 3 week retention interval. The proposed hypothesis that memory of stimuli is better for stimuli with more features, was partly confirmed. The hypothesis that confidence is higher for stimuli with more features, indicated by a high confidence-accuracy correlation, was also partly confirmed.

The object display format did have an effect on memory accuracy. In the immediate condition, words were less accurately remembered than both drawings and photos. In the delay condition, performance in all categories was significantly lower, but the same pattern was found; words were less accurately remembered than drawings and photos. Commonly used words such as ‘house’ seemed to be easier forgotten than more unusual words, which is a common finding in recognition of low versus high frequency words (Wolters, 1980). But due to the low amount of unusual words used in this experiment, this effect has not been tested.

While several studies show the enhancing effects of colour (Davidoff, 1991; Wichmann, Sharpe & Gegenfurtner, 2002) or surface depth (Chainay & Humphreys, 2001) on memory of graphical stimuli, there were no significant differences between the drawing and photo categories. This indicates that the amount of features of graphical stimuli has no effect on memory accuracy. Objects presented as black lines were equally well remembered as objects presented in colour and in full detail. These findings concur with the results reported by Nelson, Metzler and Reed (1974), in which words, line drawings, line drawings with extra details, and photos were displayed, and of Anglin and Levie (1985) who presented words, line drawings, black-and-white photos and colour photos. In both of these studies, the graphical stimuli were better remembered than the verbal stimuli, but there was no significant difference between the types of graphical stimuli.

The results suggest that verbal stimuli are processed distinctively different from graphical stimuli. Probably words are processed more in terms of semantic meanings and associations, whereas graphical stimuli are processed more in terms of distinctive perceptual and conceptual features. Research showed that faces were better remembered than objects (Dobson & Rust, 1994). Memory for objects depends on the extent to which it is conceptually distinct from other objects and it does not depend on featural distinctiveness such as colour or shape (Konkle, Brady, Alvarez & Oliva, 2008). Further research on this subject may be on the features that elaborate a significant difference in memory accuracy between drawings and photos.

The 3 week delay had a large impact on all item categories, demonstrating the effects of gradual forgetting (Schacter, 1999). The participants that were immediately tested, remembered at least half of the presented items, 50% of the verbal stimuli and more than 67% of the graphical stimuli. The participants that were tested after 3 weeks had much lower accuracy rates. Corrected for false alarms, none of the words and only 20% of the graphical stimuli were remembered.

The object display format did have an effect on the confidence of a memory as well. The confidence levels were quite high in the immediate condition. The same pattern as for accuracy was shown. Confidence levels for words were lower than for drawings and photos, and there was little difference between drawings and photos. This similar pattern could indicate a strong accuracy-confidence correlation, however, the overall accuracy-confidence correlation was rather weak. For the individual item categories higher correlations were found. The correlation for the words category was substantial, and for the drawings and photos categories, the correlation was high. The results indicate that the amount of confidence can be a good indication for accuracy, especially if the stimuli are graphical and if testing is right after the stimuli were shown.

In the delay condition, confidence levels for all item categories were significantly lower. More surprisingly, confidence levels for the item-types had the same, average values. Confidence did decrease, but not as much as would be expected from the low accuracy rates. These results indicate overconfidence of the participants. The accuracy-confidence correlations per item category considerably decreased as well. The correlations show that in the delay condition, for both verbal and graphical stimuli, confidence does not reliably indicate accuracy. These findings concur with the results reported by Odinot and Wolters (2006), that after a longer retention interval, witnesses provide less accurate information with the highest confidence ratings. One reason for relatively high confidence levels after a delay might have been that part of the items were categorized into a number of themes. Confidence for items that belong to a theme could have increased due to being familiar with a general theme (Chandler, 1994). While not deliberately set up, part of the items that were presented could be classified into themes, such as ‘animals’ or ‘home appliances’. Many of the items belonging to the ‘animals’ theme had rather high confidence ratings, irrespective of the accuracy of the response. However, a post-hoc test indicated that either the participants did not attempt to categorize the items or that familiarity with a general theme did not increase confidence.

A correlation that was not at all affected by a 3 week delay, was the amount of perceived details that were remembered, related to the level of confidence. Items that were remembered in detail had very high confidence levels, while items that were superficially remembered, had significantly lower, medium confidence levels. The 3 week delay condition group showed the same results. After 3 weeks, obviously the number of items that can be remembered accurately and with great confidence, is smaller. But the few items that were clearly remembered, were apparently remembered with the same high level of confidence as did the immediate condition group. The results suggest that the level of confidence is primarily based on the amount of details that can be remembered of the stimuli. People use the same criteria to rate their confidence, it does not seem to differ if the stimuli were seen a few minutes ago or a few weeks ago.

For practical use, this study shows that the format in which objects are presented can have different effects on remembering of these objects. Advertisers who only use words to present their products should consider that words are less likely to be remembered. Eye witnesses that very confidently claim that they are very sure of what they have seen, can be reliable when a few conditions are met: the eye witness should be interrogated almost immediately (the retention interval should be short) and the memory is of objects seen rather than of written or printed words.

References

Anglin, G.J., & Levie, W.H. (1985). Role of visual richness in picture recognition memory. *Perceptual and Motor Skills, 61*, 1303–1306.

Bradley, S.D., Angelini, J.R., & Lee, Sungkyoung. (2007). Psychophysiological and memory effects of negative political ads: Aversive, arousing, and well remembered. *Journal of Advertising, 36,* 115–127.

Busey, T.A., Tunnicliff, J., Loftus, G.R., & Loftus, E.F. (2000). Accounts of the confidence-accuracy relation in recognition memory. *Psychonomic Bulletin & Review, 7,* 26-48.

Chainay, H., & Humphreys, G.W. (2001). The real-object advantage in agnosia: Evidence for a role of surface and depth information in object recognition. *Cognitive Neuropsychology, 18,* 175–191.

Chandler, C.C. (1994). Studying related pictures can reduce accuracy, but increase confidence, in a modified recognition test. *Memory & Cognition, 22,* 273-280.

Davidoff, J.B. (1991). *Cognition through color.* Cambridge, MA: MIT Press.

Deffenbacher, K.A., Leu, J.R., & Brown, E.L. (1981). Memory for faces: Testing method, encoding strategy, and confidence. *The American Journal of Psychology, 94,* 13-26.

Dobson, E., & Rust, J.O. (1994). Memory for objects and faces by the mentally retarded and nonretarded. *Journal of Psychology, 128,* 315–322.

Grady, C.L., Mcintosh, A.R., Rajah, M.N., & Craik, F.I.M. (1998). Neural correlates of the episodic encoding of pictures and words. Proceedings of the National Academy of Sciences, 95, 2703–2708.

Granhag, P.A., Stromwall, L.A., & Allwood, C.M. (2000). Effects of reiteration, hindsight bias, and memory on realism in eyewitness confidence. *Applied Cognitive Psychology, 14,* 397-420.

Haber, R.N., & Myers, B.L. (1982). Memory for pictograms, pictures, and words separately and all mixed up. *Perception, 11,* 57-64.

Kensinger, E.A., Garoff-Eaton, R.J., & Schacter, D.L. (2007). How negative emotion enhances the visual specificity of a memory. *Journal of Cognitive Neuroscience, 19,* 1872-1887.

Konkle, T., Brady, T., Alvarez, G., & Oliva, A. (2008). Remembering thousands of objects with high fidelity. *Journal of Vision, 8,* 694-694a.

Leder, H. (1996). Line drawings of faces reduce configural processing. *Perception, 25,* 355–366.

Leippe, M.R. (1980). Effects of integrative memorial and cognitive processes on the correspondence of eyewitness accuracy and confidence. *Law and Human Behavior, 4,* 261-274.

Lindsay, D.S., Read, J.D., & Sharma, K. (1998). Accuracy and confidence in person identification: the relationship is strong when witnessing conditions vary widely. *Psychological Science, 9,* 215–218.

Loftus, E.F. (2003). Make-believe memories. *American Psychologist, 58,* 864-873.

McKelvie, S.J., Standing, L., St.Jean, D., Law, J. (1993). Gender differences in recognition memory for faces and cars: Evidence for the interest hypothesis. *Bulletin of the Psychonomic Society, 31,* 447-448.

Nelson, T.O., Metzler, J., & Reed, D.A. (1974). Role of details in the long-term recognition of pictures and verbal descriptions. *Journal of Experimental Psychology, 102,* 184-186.

Noice, H., & Noice, T. (2001). Learning dialogue with and without movement. *Memory & Cognition, 29,* 820-827.

Odinot, G., & Wolters, G. (2006). Repeated recall, retention interval and the accuracy : Confidence relation in eyewitness memory. Applied Cognitive Psychology, 20, 973-985.

Paivio, A. (1986). *Mental representation: A dual coding approach.* Oxford: Oxford University.

Park, D.C., Royal, D., Dudley, W., & Morrell, R. (1988). Forgetting of pictures over a long retention interval in young and older adults. *Psychology and Aging, 3,* 94-95.

Pezdek, K., Whetstone, T., Reynolds, K., Askari, N., & Dougherty, T. (1989). Memory for real-world scenes: The role of consistency with schema expectation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15,* 587-595.

Rajaram, S., & Roediger, H.L. (1993). Direct comparison of four implicit memory tests. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 765-776.

Regan, D. (2000). *Human perception of objects: Early visual processing of spatial form defined by luminance, color, texture, motion and binocular disparity.* Sunderland, MA: Sinauer Asso-ciates).

Schacter, D.L. (1999). The seven sins of memory: Insights from psychology and cognitive neuroscience. *American Psychologist, 54,* 182-203.

Smith, V.L., Kassin, S.M., & Ellsworth, P.C. (1989). Eyewitness accuracy and confidence: Within- versus between-subjects correlations. *Journal of Applied Psychology, 74,* 356-359.

Snodgrass, J.G., & Vanderwart, M. (1980). A standardized set of 260 pictures: Norms for name agreement, familiarity and visual complexity. *Journal of Experimental Psychology: Human Learning & Memory, 6,* 174-215.

Sporer, S.L. (1993). Eyewitness identification accuracy, confidence, and decision times in simultaneous and sequential lineups. *Journal of Applied Psychology, 78,* 22-33.

Suzuki, K., & Takahashi, R. (1997). Effectiveness of color in picture recognition memory. *Japanese Psychological Research, 39,* 25-32.

Turtle, J.W., & Yuille, J. C. (1994). Lost but not forgotten details: Repeated eyewitness recall leads to reminiscence but not hypermnesia. *Journal of Applied Psychology, 79,* 260–271.

Wichmann, F.A., Sharpe, L.T., & Gegenfurtner, K.R. (2002). The contributions of color to recognition memory for natural scenes. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28,* 509–520.

Wolters, G. (1980). Attribute models and the effect of frequency and imagery values on word recognition. *Acta Psychologica, 44,* 269-279.

Appendix A

Table A1. Accuracy rates for the item categories in the immediate condition.

Participants (*N* = 19)	**Words** (*N* = 30)		**Drawings** (*N* = 30)		**Photos** (*N* = 30)		**Distractors** (*N* = 90)	
	Hits	Missed Signals	Hits	Missed Signals	Hits	Missed Signals	Correct Rejected	False Alarms
1. accuracy rate	11	19	22	8	27	3	75	15
2. accuracy rate	22	8	30	0	29	1	53	37
3. accuracy rate	22	8	24	6	22	8	80	10
4. accuracy rate	23	7	26	4	23	7	71	19
5. accuracy rate	13	17	27	3	23	7	84	6
6. accuracy rate	18	12	29	1	29	1	88	2
7. accuracy rate	18	12	23	7	27	3	60	30
8. accuracy rate	22	8	25	5	28	2	81	9
9. accuracy rate	23	7	27	3	28	2	85	5
10. accuracy rate	25	5	26	4	27	3	54	36
11. accuracy rate	23	7	29	1	25	5	75	15
12. accuracy rate	17	13	25	5	29	1	83	7
13. accuracy rate	16	14	27	3	27	3	83	7
14. accuracy rate	12	18	23	7	24	6	84	6
15. accuracy rate	22	8	17	13	24	6	87	3
16. accuracy rate	12	18	22	8	27	3	66	24
17. accuracy rate	22	8	27	3	28	2	84	6
18. accuracy rate	26	4	21	9	26	4	84	6
19. accuracy rate	17	13	18	12	20	10	90	0
M accuracy rate of immediate condition group	19.16	10.84	24.63	5.37	25.95	4.05	77.21	12.79
Proportion	0.64	0.36	0.82	0.18	0.87	0.14	0.86	0.14

Table A2. Accuracy rates for the item categories in the delay condition.

Participants (*N* = 20)	**Words** (*N* = 30)		**Drawings** (*N* = 30)		**Photos** (*N* = 30)		**Distractors** (*N* = 90)	
	Hits	Missed Signals	Hits	Missed Signals	Hits	Missed Signals	Correct Rejected	False Alarms
20. accuracy rate	16	14	23	7	21	9	43	47
21. accuracy rate	5	25	13	17	12	18	71	19
22. accuracy rate	12	18	16	14	15	15	64	26
23. accuracy rate	10	20	24	6	20	10	49	41
24. accuracy rate	17	13	22	8	19	11	44	46

25. accuracy rate	20	10	21	9	20	10	39	51
26. accuracy rate	13	17	21	9	19	11	55	35
27. accuracy rate	16	14	23	7	20	10	54	36
28. accuracy rate	12	18	22	8	24	6	60	30
29. accuracy rate	15	15	25	5	24	6	37	53
30. accuracy rate	17	13	21	9	21	9	45	45
31. accuracy rate	11	19	22	8	21	9	43	47
32. accuracy rate	11	19	23	7	15	15	58	32
33. accuracy rate	7	23	12	18	11	19	69	21
34. accuracy rate	5	25	15	15	9	21	60	30
35. accuracy rate	18	12	22	8	14	16	43	47
36. accuracy rate	15	15	24	6	23	7	30	60
37. accuracy rate	10	20	17	13	10	20	55	35
38. accuracy rate	22	8	24	6	20	10	27	63
39. accuracy rate	6	24	6	24	10	20	67	23
M accuracy rate of delay condition group	12.90	17.10	19.80	10.20	17.40	12.60	50.65	39.35
Proportion	0.43	0.57	0.66	0.34	0.58	0.42	0.56	0.44

Appendix B

Table B1. Average confidence levels for the item categories in the immediate condition.

Participants (*N* = 19)	**Words** (*N* = 30)		**Drawings** (*N* = 30)		**Photos** (*N* = 30)		**Distractors** (*N* = 90)	
	Hits	Missed Signals	Hits	Missed Signals	Hits	Missed Signals	Correct Rejected	False Alarms
1. *M* confidence level	5.18	4.47	6.36	3.63	6.44	3.67	4.28	2.27
2. *M* confidence level	6.50	3.68	6.74	-	6.90	3.00	4.89	4.65
3. *M* confidence level	6.91	5.38	6.83	5.00	6.77	5.56	5.21	5.00
4. *M* confidence level	5.17	4.71	5.81	4.75	6.65	4.71	3.90	2.60
5. *M* confidence level	6.38	6.11	6.30	6.33	6.61	6.29	6.04	6.00
6. *M* confidence level	6.16	3.33	6.69	5.50	7.00	6.33	3.78	4.50
7. *M* confidence level	4.33	4.17	6.00	5.00	5.93	4.50	3.88	3.17
8. *M* confidence level	6.68	6.75	6.72	5.25	6.96	5.00	5.90	4.44
9. *M* confidence level	6.61	5.86	6.67	6.00	6.79	7.00	6.60	4.20
10. *M* confidence level	5.72	5.25	6.35	4.75	6.37	6.00	5.28	4.97
11. *M* confidence level	6.39	5.71	6.72	4.00	6.40	4.60	4.95	4.70
12. *M* confidence level	5.47	4.22	6.00	5.40	6.59	-	5.43	4.00
13. *M* confidence level	6.75	5.93	6.70	5.67	6.59	5.00	6.23	3.58

14. *M* confidence level	4.75	4.06	5.72	3.00	5.38	5.00	4.01	5.17
15. *M* confidence level	5.95	3.63	6.12	3.54	6.67	4.67	4.16	5.00
16. *M* confidence level	5.55	3.05	6.64	3.75	6.67	4.67	2.72	5.50
17. *M* confidence level	6.37	3.91	6.74	2.00	6.86	4.00	4.93	-
18. *M* confidence level	6.16	2.60	6.10	3.56	6.73	4.00	4.32	2.80
19. *M* confidence level	4.30	4.00	4.12	4.20	4.22	4.33	4.05	4.23
M confidence level of immediate condition group	5.86	4.57	6.28	4.52	6.45	4.91	4.77	4.95

Table B2. Average confidence levels for the item categories in the delay condition.

Participants (*N* = 20)	**Words** (*N* = 30)		**Drawings** (*N* = 30)		**Photos** (*N* = 30)		**Distractors** (*N* = 90)	
	Hits	Missed Signals	Hits	Missed Signals	Hits	Missed Signals	Correct Rejected	False Alarms
20. *M* confidence level	2.75	2.71	2.87	2.67	3.00	2.56	2.40	2.83
21. *M* confidence level	3.20	3.17	3.54	2.56	4.41	3.00	2.90	3.58
22. *M* confidence level	2.83	2.89	4.12	3.00	2.80	3.00	2.95	3.00
23. *M* confidence level	4.80	4.71	5.08	4.43	5.15	4.09	4.72	4.70
24. *M* confidence level	5.12	4.77	5.23	4.75	5.00	5.08	4.79	4.22
25. *M* confidence level	5.90	2.40	5.76	1.89	5.05	2.70	2.79	5.37
26. *M* confidence level	4.69	4.50	4.38	4.89	4.68	4.54	4.60	4.17
27. *M* confidence level	4.37	3.12	4.74	3.25	5.05	3.29	3.49	3.36
28. *M* confidence level	4.50	4.33	4.77	4.25	4.79	3.88	4.18	4.70
29. *M* confidence level	4.50	4.00	4.44	3.50	4.58	4.00	3.96	4.40
30. *M* confidence level	4.59	4.10	4.71	4.07	5.09	4.00	3.77	4.04
31. *M* confidence level	5.91	5.47	5.77	5.50	5.81	6.22	5.95	5.51
32. *M* confidence level	4.27	3.42	4.83	3.71	4.33	2.93	3.36	4.19
33. *M* confidence level	3.43	3.17	3.50	2.78	3.73	2.89	2.97	3.38
34. *M* confidence level	5.00	4.68	5.53	5.07	5.22	5.10	4.83	5.52
35. *M* confidence level	3.41	4.38	4.10	3.78	3.86	5.06	4.57	3.73
36. *M* confidence level	4.67	4.60	5.04	2.50	4.91	4.86	3.26	4.76
37. *M* confidence level	5.10	3.30	5.44	3.17	5.80	3.50	3.66	4.46
38. *M* confidence level	3.14	4.11	4.29	2.33	3.80	3.90	3.54	3.65
39. *M* confidence level	5.17	5.75	4.00	5.92	4.60	5.35	5.75	4.12
M confidence level of delay condition group	4.37	3.98	4.61	3.70	4.58	4.00	3.92	3.95