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Experimental dissociations between memory measures: influence of retrieval strategies

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Abstract

The objective of this study was to explore the participants' processing strategies on the mere exposure effect, object decision priming and explicit recognition. In Experiments 1, we observed that recognition and the mere exposure effect for unfamiliar three-dimensional objects were not dissociated by plane rotations in the same way as recognition and object decision priming. However, we showed that, under identical conditions, prompting analytic (part-based) processing at testing produced a large plane rotation effect on recognition and the mere exposure effect similar to that observed for object decision priming (Experiment 2). Furthermore, inducing a non-analytic (whole-based) processing strategy at testing produced a reduced plane rotation effect on recognition and object decision (Experiments 3 & 4), similar to that observed for the mere exposure effect. These findings suggest that participants' processing strategies influence performance on the three tasks.

Key Words: *Fluency, Mere exposure effect, Priming, Recognition, Strategy.*

Experimental dissociations between memory measures: influence of retrieval strategies

Experimental dissociations between examples of performance on perceptual tests of implicit memory and of performance on explicit recognition tasks have been one of the most important data sources suggesting the independence of the mechanisms underlying implicit and explicit memory (for reviews, see Schacter, 1987). A very well-documented example comes from studies showing that explicit recognition and perceptual priming (i.e., the facilitation or bias in the processing of a stimulus as a function of a recent encounter with that stimulus) are differentially sensitive to various visual transformations of stimuli between study and test times. This kind of cognitive dissociation can be illustrated by studies using the paradigm of *object decision priming paradigm* developed by Schacter, Cooper, and their colleagues (Schacter, Cooper, & Delaney, 1990). The test task is to judge whether line drawings represent possible objects, that could exist in three dimensions, or impossible objects, that could not actually exist in the real three dimensional world (Figure 1). Participants first study a set of target stimuli, then are tested on studied target and Participants and unstudied distracter stimuli. Priming effect is revealed if participants show significant increase of performance for studied compared to unstudied test stimuli. By using this paradigm, Williams and Tarr (1999) observed that explicit recognition was affected less by study-to-test plane rotation than the priming effect (see also Cooper and Schacter, 1992). Conversely, reflection, size transformations or depth-rotation of three-dimensional objects between study and test have been shown to decrease explicit recognition but not object decision priming or implicit performances measured by other perceptual tests (e.g., Cooper, Schacter, Ballesteros, & Moore, 1992; Seamon et al., 1997; Seamon & Delgado, 1999).

A still more striking example is provided by studies of the *mere exposure effect* with very brief presentation at study phase. In these studies, novel visual stimuli are previously shown very shortly (e.g., 1 millisecond, Kunst-Wilson & Zajonc, 1980). In a subsequent test phase, target-distractor pairs are presented. Participants are asked to select either the old stimulus (i.e., explicit recognition) or the more pleasant stimulus (i.e., a judgment that does not ask subjects to recollect the prior encoding phase). While explicit recognition was shown to be null (i.e., at chance), the old stimuli were much more likely to be selected than the new ones in the preference judgment (e.g., Kunst-Wilson & Zajonc, 1980; Mandler, Nakamura, & van Zandt, 1987; Seamon, Brody, & Kauff, 1983a, 1983b).

These studies suggest that different representations with different qualities underlie perceptual implicit performance on the one hand, and explicit recognition on the other. For example, perceptual priming and the mere exposure effect could be mediated by an enhanced "*perceptual fluency*" underlain by a presemantic Perceptual Representation System (PRS) dedicated to capturing information regarding perceptual inputs. In contrast, explicit recognition could depend on an episodic memory system, dedicated to coding spatial, temporal, contextual or semantic information that creates distinctive representations (Butler, Berry, & Helman, 2004; Schacter, Cooper, & Delaney, 1990; Seamon, et al., 1997). However, in spite of the similarities between the various effects of perceptual implicit memory, numerous functional differences have also been observed. Intriguingly, this kind of experimental dissociation has mostly attracted less attention within the memory literature. For example, Butler et al. (2004) observed that the mere exposure effect was differentially sensitive to real words and non-words, with an effect only for non-words, while they found an equal priming effect for both words and non-words using a perceptual identification task. Similarly, Seamon et al. (1995, 1997) found an mere exposure effect on structurally impossible three-dimensional objects (i.e., objects that cannot actually exist in the real world) for which an object decision priming was not observed (e.g., Cooper et al., 1992; Schacter & Cooper, 1993; Schacter, Cooper, Delaney, Peterson, & Tharan, 1991; Schacter, Cooper, Tharan, & Rubens, 1991; see also Liu & Cooper, 2001; Holbrook, Bost, & Cave, 2003; Williams & Tarr, 1997, 1999, however see Carrasco & Seamon, 1996; Ratcliff & McKoon, 1995). In conclusion, although some evidence is suggestive of a common mechanism underlying the mere exposure effect and perceptual priming (see Seamon et al., 1997; Seamon & Delgado, 1999), several authors have suggested the possibility that the mere exposure effect could be based on a different type of memory representation than the one responsible for perceptual priming (Butler, Berry, & Helman, 2004; Seamon et al., 1995).

Another point of view could offer a quite straightforward explanation by assuming that this kind of experimental dissociation does not result from different forms of memory representation, but instead from two different forms of processing – analytic or non-analytic – applied to the same representations in different tasks (Whittlesea & Price, 2001). An analytic form of processing corresponds to isolating some distinctive parts composing a stimulus, for example to see whether any of them acts as a cue for recalling the context in which the stimulus had been previously encountered. On the other hand, a non-analytic form of processing corresponds to examining the stimulus as a whole.

Regarding more specifically the dissociation between the mere exposure effect and explicit recognition following short presentation at the encoding phase, Whittlesea and Price (2001) suggested that, due to the characteristics of the encoding task and the material to be processed, people may shift between these different forms of processing under the liking or recognition condition. As highlighted by these authors, in most studies of the mere exposure effect, the material to be encoded is unfamiliar, encoding opportunities are minimal (i.e., presentation is brief), and test items are perceptually similar (e.g., they belong to a single stimulus class). In this context, the perceived difficulty of the explicit recognition task would encourage participants both to adopt an analytic strategy, which they judge to be more reliable, and to attempt to look for distinctive and recognizable details in the items. However, this analytic strategy fails because the rapid presentation prevents the effective encoding of such features. Conversely, because participants may perceive the liking tasks as easier and purely subjective, they tend simply to process stimuli non-analytically. If the whole stimulus generates a feeling of fluency due to stimulus repetition, then this feeling is attributed to the most salient or plausible dimension in the environment (i.e., pleasantness in the context of the liking task, Seamon, Braudy & Kauff, 1983a, see also Bornstein & D'Agostino, 1992, 1994).

The question addressed by this study is whether these different strategies may also explain other experimental dissociations, aside from the mere exposure effect and recognition, and in particular the dissociation between the mere exposure effect and object decision priming (Seamon et al., 1995, 1997). In this context, one possible interpretation could be that, contrary to the liking tasks in the mere exposure effect paradigm, the objectivity and the concrete demands of the possible/impossible object-decision task but also the greater difficulty perceived by participants motivates subjects to analyze the stimulus into components (i.e., an analytic processing). Indeed, in order to isolate the potentially erroneous local part of the object, participants could treat each stimulus as a collection of separate, possible and impossible, portions. This part-based processing could have two major consequences. Firstly, an analytic processing might block the experience of the global feeling of fluency. Indeed, Whittlesea and Price (2001) demonstrated that, even when a stimulus is presented in the same form as it was encountered earlier, if the participants analyze the stimulus into parts at testing, they will not experience enhanced perceptual processing fluency. Secondly, analytic processing could lead participants to retrieve different aspects of a memory representation than those underlying the mere exposure effect in liking tasks. Indeed, in liking tasks participants could base their subjective liking responses simply on the experience of global fluency. Whereas, if participants isolated some of the parts of which a stimulus is composed to make their possible/impossible object-decision, these parts might act as retrieval cues and ensure access to information associated with critical features. For example, a participant who has seen an unfamiliar three-dimensional object may later recognize it by remembering that he or she had thought that one of its parts resembled a steeple or that this specific portion of the configuration was complex or erroneous (for a similar point of view, see McKoon & Ratcliff, 1995; Ratcliff & McKoon, 1995). Consequently, it appears that experimental dissociations between the mere exposure effect, perceptual priming and explicit recognition do not inevitably involve an explanation in terms of different forms of memory representation. Instead, we suggest that the mere exposure effect, priming effects and recognition could partially tap into the same use of overall fluency impressions. However, some experimental conditions, such as possible/impossible object-decision tasks and some recognition tasks, may also induce an analytic processing preventing a perceptual fluency experience.

Finally, the mere exposure effect and perceptual priming have often been compared by independent studies, which examine one effect or the other, but not both together (see Butler et al., 2004, for an exception). This makes it very difficult to compare them, given that different procedures and task formats are employed. Therefore, our goal in this study was to compare more directly the mere exposure effect and object decision priming with explicit recognition memory. More specifically, we first investigated different variables that can produce dissociations between both implicit measures or between implicit and explicit memory measures (Experiment 1). The first variable was the possible vs. impossible nature of objects, which has a differential effect on the mere exposure effect and on object decision priming with mere exposure effect for both types of object and object decision priming only for possible objects (Seamon et al., 1995). The second variable was a visual transformation between study and test times, more specifically, a plane rotation that largely affects less explicit recognition than object decision priming (Cooper & Schacter, 1992; Williams & Tarr, 1999). In the next experiments, we investigated whether these task dissociations could result from different processing strategies adopted by the participants by implementing analytic or non-analytic instructions (Experiments 2 and 3), and by giving a short response deadline in order to prevent the analyze of distinctive information (Experiment 4).

EXPERIMENT 1

Object decision, Liking, and Recognition

Plane rotation between study and test times has been well studied and is said to have a larger effect on object decision priming than on explicit recognition (Cooper & Schacter, 1992; Williams & Tarr, 1999). The goal of our first experiments was therefore to reproduce this pattern of data by using the possible/impossible object-decision task (priming; Experiment 1A), on the one hand, and the liking task (mere exposure effect, Experiment 1B), on the other, using the same material, procedure and task format. If the mere exposure (mere exposure effect) and priming effects are based on the same memory representations or processes, we might expect to observe that rotation has a similar major impact on the mere exposure effect as it does with priming. In addition, we attempted to replicate the differential effect of the object type (possible or impossible) on the mere exposure effect and object decision priming (Seamon et al., 1995, 1997).

Method

Participants: Forty-eight Liège and Geneva University students participated in Experiment 1A, and 24 in Experiment 1B.

Materials: Sixty-four line drawings of unfamiliar possible and impossible three-dimensional objects were used (see Figure 1, for examples of stimuli). Forty objects came from Williams and Tarr (see 1997, for a detailed description of the materials), and 24 objects were created for this study respecting the characteristics of Williams and Tarr’s materials. For the evaluation of the clear perception of the nature of possible/impossible objects, 24 additional participants were asked to decide, without a time limit, whether each of the 64 objects was possible or impossible. On average, possible objects were classified as "possible" by 90% (standard deviation: 5) of the participants and impossible objects were correctly classified by 88% (standard deviation: 4) of the participants. In addition, decision accuracy on the 24 new objects that we created did not differ from the accuracy of Williams and Tarr's figures and no difference was observed between possible and impossible objects (all *Fs* < 1).

INSERT FIGURE 1 ABOUT HERE

Liking judgments can be influenced by many cues other than perceptual fluency, due to pre-exposure (such as complexity, Lombardo, 1991; figure-ground contrast, Reber, Winkielman, & Schwarz, 1998; size, Silvera, Josephs, & Giesler, 2002; symmetry, Jones, Little, & Perrett, 2003; averageness, Rhodes, Sumich, & Byatt, 1999; etc.). For this reason, in contrast to Williams and Tarr (1999), we avoided as much as possible presenting the objects from their most canonical views during both the study and test phases in order to prevent a potential liking bias. Thus we first asked another sample of 16 participants to position each object freely in its most canonical orientation. Then, avoiding these most canonical views, six copies of each object were created by plane rotation (0°, ±60°, ±120°, or 180°, clockwise: +, counterclockwise: –, see Figure 2). The 64 stimuli were randomly divided into two sets (set A and B). Half of the subjects were presented with set A as the target and set B as distractors. The other half of the subjects were presented with the reverse design. Moreover, both set were divided into 4 groups of stimuli in order to counterbalance the stimuli allocated to the four orientations of studied items (0°, ±60°, ±120°, or 180°) [1].

Material was presented using E-Prime software (Psychology Software Tools, Inc.) on a 17” color monitor running at 60 Hz, approximately 50 cm from the participant. The objects were about 6 cm high and 6 cm wide, resulting in a visual angle of 6.8°. They were presented in gray on black. Our previous work has shown a particularly robust mere exposure effect with this material and color format (Willems & Van der Linden, 2006).

INSERT FIGURE 2 ABOUT HERE

Procedure: Participants were instructed only that the study involved “objects perception” and that they would be making judgments and decisions about novel objects. All instructions were presented automatically to participants on the computer screen.

Incidental study tasks: Participants were told that they were going to see figures in the context of different judgments. In the first encoding task, participants were requested to decide which direction they thought each object was facing (left or right); in the second, they had to decide whether the object looked like a building, tool, or spaceship; in the third, they counted the number of visible surfaces on the figures; and in the fourth, they rated how complex each object seemed on a 5-point scale. We selected this diversified encoding task procedure previously used by Williams and Tarr (1999) for two main reasons. Firstly, our primary aim (Experiment 1A) was to reproduce the same dissociation between object decision priming and explicit recognition that Williams and Tarr had observed, before investigating the mere exposure effect (Experiment 1B) and introducing new manipulations (Experiments 2-3). Secondly, this diversified encoding procedure aimed to make participants efficiently encode part-related and whole-related information. Consequently, the use of both analytic and non-analytic processing as strategies that can generate information about a stimulus should be similarly efficient.

Thus participants received 4 trials with the same set of stimuli, but with a different judgment task for those stimuli on each trial. They entered their choices using the PST Serial Response Box (Psychology Software Tools, Inc.). No mention was made of any subsequent memory test or the impossible-possible nature of the figures. Participants were then presented with 32 gray-on-black figures (16 possible and 16 impossible), four times each, in four random orders of 32. Each study stimulus was presented in the center of the screen for 5-s, followed by a 3.5-s interval. Immediately following this study phase, participants received instructions for the implicit memory task (Liking or object decision tasks) and the recognition judgment task.

Object decision and Liking tasks: In Experiment 1A, participants were informed that some objects represented "three-dimensional objects that could exist in the real, three-dimensional world," whereas others represented "impossible objects that could not actually exist in the real, three-dimensional world." Participants were told to decide whether *the object was possible, yes or no,* as quickly and as accurately as possible. Here, the test trials were preceded by six practice figures, for which the participants made decisions and received automatic feedback. Their understanding of the impossible/possible distinction was checked by the experimenter before the beginning of the test phase. In Experiment 1B, participants were simply asked to examine each object and to decide whether *the object was pleasant, yes or no,* as quickly as possible.

Participants saw a random list of 32 studied and 16 unstudied distractor objects. Figures were presented until the participant responded or 4-s had elapsed. Each trial began with a 1.5-s blank screen followed by a 500-ms fixation point. The interstimulus interval was thus 2-s, computer-spaced.

Explicit recognition task: The same items, in the same orientation, as in the implicit memory tasks were displayed. Participants were informed that the objects might appear in different orientations in comparison with the orientations in the study phase (as in Williams & Tarr, 1999). For each figure, participants had to say whether they had seen it before. The sequence of trials was identical to that described for the object decision task.

Half of the participants were presented with the object decision task (Experiment 1A) or with the liking task (Experiment 1B) first and the recognition judgment afterwards. The other half of the participants were presented with the reverse design. Participants were tested individually.

Design and analyses: For each experiment, the independent variables manipulated among the participants were Type of Object (possible vs. impossible) and Test Status, which combined Study Status and Rotation of studied objects (i.e., studied 0°, studied ±60°, studied ±120°, studied 180°, and unstudied objects). The dependent variables were the proportion of correct responses in object decision (i.e., accuracy rates), and the proportion of preference and recognition responses for studied objects (Hit responses) and for unstudied objects (false alarms, FA). The use of proportion of responses as main dependent variable ensured to have very similar measure of memory in the three tasks. However, response times (RTs) will also be reported for priming.

Results and Discussion

For the various tasks, preliminary analysis revealed that the clockwise/counterclockwise rotation condition and task order affected neither the response proportions nor RTs (all $Fs < 1$). Importantly, the absence of any effect of task order showed the limited influence of explicit recognition on implicit memory tasks. Consequently, we did not consider these variables in the following analyses[2].

Experiment 1A (Object decision priming and Recognition): We detailed the rotation effects on priming and on recognition separately before to analyze the differences between the patterns of rotation effects on the both tasks. To evidence memory effect, a-priori contrast tests were computed in order to check whether the proportion of correct responses for targets was greater than for never seen distractors.

In the object decision task, a 5 X 2 ANOVA on correct response proportion (accuracy rates, see Table 1) with Test Status (studied 0°, studied ±60°, studied ±120°, studied 180°, and unstudied objects) and Object Type (possible, impossible) showed a significant main Object Type effect with an advantage for possible objects ($F(1, 47) = 12.13$, $p = .001$) but no other significant effect (all $Fs < 1.8$). The a-priori contrast test nevertheless showed a significant priming effect but only for possible objects with 0° study-to-test rotation ($F(1, 47) = 8.224$, $p = .006$), and not for other possible objects (all $Fs < 1.5$) or impossible objects (all $Fs < 1$). Regarding RTs for correct responses, we observed a very similar pattern of results with a robust priming for possible objects with 0° study-to-test rotation ($F(1, 47) = 61.632$, $p <.001$) and an absence of priming for impossible objects (all $Fs < 1$) and for possible objects in other Rotation conditions (all $Fs < 1$)[3]. These findings were consistent with those obtained by Williams and Tarr (1999), who found that large plane rotations dramatically affect priming in the object decision task. Indeed, we noted a significant object decision priming on accuracy rates (more studied objects classified correctly), but only when objects were in the same orientation at the test and study phases.

In the explicit recognition task, the 5 X 2 ANOVA on “Yes, old” response proportion showed a significant main effect for Test Status ($F(4, 188) = 53.965$, $p < .001$) but no other significant effects (all $Fs < 1.5$). The a-priori contrast test indicated that participants gave more “Yes, old” (Hit) recognition responses to all the studied objects (regardless of Rotation and Object Type), than “Yes, old” (false alarm, FA) responses to unstudied objects (all $Fs > 41$). However, contrast test on studied objects with both possible and impossible objects taken together (weights: studied 0° = –3, studied ±15° = –1, studied ±45° = +1, studied ±90° = +3) showed a significant linear Rotation effect on Hit proportions ($F = 21.9$, $p < .001$).

INSERT TABLE 1 ABOUT HERE

Differences between the patterns of orientation effects in the object decision and recognition tasks were addressed with 2 X 4 ANOVA on accuracy for studied objects with the two factors of Task (Object Decision vs. Recognition) and Rotation, leaving out unstudied items (studied 0°, studied ±60°, studied ±120°, studied 180°). Because no significant priming effects was observed for impossible objects these trials were not analyzed here. The interaction of these factors was significant ($F(3, 141) = 2.864$, $p = .04$). The same analysis on RTs revealed also an interaction between the two factors ($F(3, 141) = 6.095$, $p < .001$). These interactions indicated that object decision priming and explicit recognition performance was differentially sensitive to larger study-to-test rotations. Thus, as observed by Williams and Tarr (1999), while recognition performance gradually decreased with rotation amplitude, priming disappeared abruptly at the 60° rotation level. This replication indicates that our stimuli and procedure are capable of producing the same result pattern of study-to-test rotation effects on object priming and explicit recognition observed by previous studies (Cooper & Schacter, 1992; Williams & Tarr, 1999).

Experiment 1B (Liking and Recognition): This experiment was identical to Experiment 1A, except in the implicit memory task instructions. Thus, we performed the same steps in analyzing this experiment.

In the liking task, the 5 X 2 ANOVA showed a significant main effect for Test Status ($F(4, 92) = 5.916$, $p < .001$), but no other effect (all $Fs < 1.1$) (see Table 2). A-priori contrast test showed a mere exposure effect for possible objects with 0° and 180° study-to-test rotation and a marginal effect with 60° rotation (0°: $F(1, 23) = 12.220$, $p = .002$; 180°: $F(1, 23) = 5.173$, $p = .03$; 60°: $F(1, 23) = 3.336$, $p = .08$), but no effect for studied possible objects with 120° rotation ($F = .822$). Similarly, a significant mere exposure effect was noted for impossible objects in the 0°, 60°, and 180° conditions (0°: $F(1, 23) = 14.698$, $p < .001$; 60°: $F(1, 23) = 4.307$, $p = .049$; 180°: $F(1, 23) = 11.707$, $p = .002$), but again not for studied objects in the 120° rotation condition ($F(1, 23) = 2.75$, $p = .11$). Finally, for possible and impossible objects taken together, a linear contrast test on liked studied objects showed a marginally significant Rotation effect ($F(1, 23) = 3.309$, $p = .08$). Thus, a slight linear decline in the mere exposure effect was observed with rotation from 0° to 120°, with no mere exposure effect at all for the 120° condition. However, a slight revival in the mere exposure effect was noted for 180°-rotated objects. One possible explanation of this result could be that the global visual form and position in space of the 0° study version overlap more with the visual form of the 180° test version than with that of the 120° test version (e.g., an object that is elongated and vertical is still elongated and vertical after a 180° rotation but became slantwise after a 120° rotation). Thus, the 180° rotation may affect a whole-image-based process to a lesser degree than a 120° rotation (see Marsolek & Burgund, 2005).

Concerning the proportion of recognition responses, as observed in Experiment 1A, the 5 X 2 ANOVA indicated significant main effects for Test Status on response proportion ($F(4, 92) = 25.636$, $p < .001$, see Table 2). In addition, Test Status did not interact with the Object Type effect (all *Fs* < 1.5). Participants gave more Hit responses than FA responses for all Rotations and Object Types (all *Fs* > 39). In addition, as observed in Experiment 1A, contrast tests showed significant linear Rotation effects, for both Object Types taken together, on Hit proportion ($F(1, 23) = 9.572$, $p = .002$).

INSERT TABLE 2 ABOUT HERE

ANOVA with Task (Recognition vs. Liking), Object Type (Impossible vs. Possible) and Rotation condition of the studied object (0°, ±60°, ±120°, 180°) was conducted on the proportions of recognition responses and of liked objects. Interestingly, this revealed no significant Task × Rotation interaction ($F\ (3, 69) = 2$). Unlike in Experiment 1A, we did not find an implicit/explicit differential effect created by object rotation between study and test times.

Thus, although affected by rotation, the mere exposure effect did not show the same extreme viewpoint dependence that was found in the object decision task in Experiment 1A. Indeed, we found a significant or nearly significant mere exposure effect in conditions that revealed no priming effect for the same materials (i.e., studied objects with 60° and 180° rotations). These findings also confirmed the relative robustness of the mere exposure effect, already observed with other stimulus transformations (changes in size or reflection, Seamon et al., 1997; depth-rotation, Seamon & Delgado, 1999) but also across different measure procedures. Indeed, many previous mere exposure effect studies used a forced-choice test on target-distractor pairs, whereas the present research employed a yes/no liking judgment. This procedure has been chosen in order to compare object decision priming and mere exposure effect with a same task format. Thus, the findings show the robustness of mere exposure effect for both possible and impossible objects and for both types of mere exposure effect testing.

To summarize the results of Experiment 1, we first observed a differential study-to-test rotation effect on object decision priming and explicit recognition (Experiment 1A), which was relatively similar to the findings reported by Williams and Tarr (1999). Conversely, we noted that study-to-test rotation produced very similar result patterns for both the mere exposure effect and explicit recognition (Experiment 1B). Moreover, like Seamon et al. (1995), we observed a mere exposure effect for impossible objects, which was not the case with object decision priming.

Non-Analytic and Analytic Strategies

The results of Experiment 1B are striking when compared with those of Experiment 1A, in that there was no significant differential effect of rotation on explicit or implicit memory tasks when an implicit liking judgment task was used (Experiment 1B), but there was one where we asked participants to make object decisions (Experiment 1A). In addition, we observed a mere exposure effect but no object decision priming for impossible objects. As explained in the introduction, the results of this first experiment are potentially consistent with the view that priming effect (observed in the object decision task) and the mere exposure effect (observed in the liking task) recruit at least partially different aspects of the object representation in memory. We proposed that, first, an object decision may prompt an analytic strategy that consists of scrutinizing each test object as a collection of separate portions. Second, this strategy might enable participants to experience fluent reprocessing of the stimulus as a whole (Whittlesea & Price, 2001). Third, this strategy might sometimes ensure them to retrieve information associated with critical details for the possible/impossible decision (McKoon & Ratcliff, 1995; Ratcliff & McKoon, 1995). In accordance with this assumption, we noted in these first experiments that object decision response times were quite slow overall (between 940 and 1295 ms, depending on the condition, as in Williams & Tarr, 1999) – slower than liking response times (all *Fs* > 5; between 897 and 1099 ms depending on Object Type). And yet an analytic strategy would likely require more resources and more time than a non-analytic strategy.

However, given that recognition tasks involving unfamiliar and generally similar material may lead participants to attempt to isolate distinctive details (i.e., analytic strategy, see Whittlesea & Price, 2001), if object decision performance depends on a similar analytic retrieval strategy, one would expect to observe a similar rotation effect on these memory measures. Conversely, object decision priming was more severely affected by plane rotation than by explicit recognition. Moreover, while the mere exposure effect has been described as depending exclusively on a non-analytic strategy, we observed a more similar rotation pattern between the mere exposure effect and explicit recognition than between object decision priming and explicit recognition.

One explanation might be that, in this study, the object decision task encourages an analytic strategy more systematically than does the recognition task. Several factors may support this hypothesis. As regards the mere exposure effect and recognition literature, a growing body of research has provided evidence suggesting that participants do not systematically perceive fluency due to pre-exposure as a useful cue for their recognition or liking decisions (e.g., Verfaellie & Cermak, 1999; Westerman, Miller, & Lloyd, 2003; Westerman, Lloyd, & Miller, 2002; Whittlesea & Williams, 1998, 2000, 2001a, b; Willems, Bastin, & Van der Linden, 2007; Willems & Van der Linden, 2006). In fact, it seems that the use of fluency as a cue is subject to metacognitive control and that the relationship between the judgment responses and fluency is indirect, mediated by attributional processes (Bornstein & D'Agostino, 1992, 1994; Jacoby & Dallas, 1981; Kelley & Rhodes, 2002) and moderated by participants' assessment of its relevance (Westerman, Lloyd, & Miller, 2002; Westerman, Miller, & Lloyd, 2003; Willems & Van der Linden, 2006). These findings may shed some light on the role of fluency in the object decision task. Indeed, in this task, fluency seems to lead subjects to respond "possible" to both possible and impossible objects that have previously studied (Ratcliff & McKoon, 1995; see also, Marsolek & Burgund, 2005; Williams & Tarr, 1997). However, in Experiment 1A, even when participants were told to respond as quickly as possible, test objects were presented until the participant responded or 4 s had elapsed (similarly to Williams & Tarr, 1999). Thus this procedural aspect gave participants time to verify their first "possibility" impressions by searching or remembering more critical features associated with actual possible and impossible object configurations (see Ratcliff & McKoon, 1995). This process strategy could help them make correct decisions about both possible and impossible objects. These two influences might explain the absence of object decision priming, often observed for impossible objects (Ratcliff & McKoon, 1995). Indeed, the bias to respond "possible" to previously studied impossible objects might be offset by the availability of specific information that indicates their impossibility (the two processes would work against each other). Consequently, when participants are given time to make a decision, fluency due to pre-exposure may be perceived as totally irrelevant, and thus uninformative, for object decision judgments. In this context, the perceived irrelevance of the overall a fluency-based possibility feeling and the objective requests of the task might encourage participants from the outset to adopt almost exclusively an analytic part-based strategy, blocking the experience of global processing fluency.

In line with Ratcliff and McKoon (1995), we therefore assumed that the processing involved in non-analytic and analytic strategies might act in concert and influences performance in object decisions for possible objects in the same way, but that it has the opposite effect on performance for impossible objects (i.e., the analytic strategy acts to produce the correct "impossible" answer, while the non-analytic one acts to produce a false "possible" response). In this context, we can use the process dissociation procedure developed by Jacoby (Jacoby, 1991) that provides measures of specific processes by setting those processes in opposition to one another. This procedure ensures to separate the contribution of the both processes by a simple calculation. We suggested that "possible" responses for impossible objects reflect the influence of non-analytic (N) processing in the absence of analytic processing ($1 - A$). Participants may respond "possible" with a global possible feeling but without the isolation of specific information that indicates their impossibility. So incorrect "Possible" responses for Impossible objects = $N\ (1 – A)$. On the other hand, participants might correctly respond "possible" for possible objects either because they have isolated and/or have retrieved diagnostic details (A), or because non-analytic processing gives a global impression of "possible object" (N) without isolating diagnostic details ($1 – A$). Thus, for these responses, A and N processes work together to facilitate the production of the "possible" responses. Thus, Correct "Possible" responses for Possible objects = $A + N\ (1 – A)$. In this context, by considering "Possible" responses we can separate the degree to which analytic and non-analytic processing provides memory cues to contribute to performance in the object decision task. Indeed, A = Possible – Impossible; N = Impossible / (1 – An). A estimation values obtained in this way for Experiment 1A data were very high for both studied and unstudied objects (means were .68 for studied objects, with all rotations taken together, and .60 for unstudied objects) – greater than N estimations (means were .35 for studied objects and .34 for unstudied objects). Since A for unstudied objects reflects simply a strategic search for diagnostic details without any influence of memory (directly available from the test object), by subtracting the A estimation for these unstudied objects from the A estimation for studied objects, we can obtain an estimation of retrieval processes capitalized by the analytic strategy (for studied 0°, ±60°, ±120°, and 180° rotations, .31, .25, .22 and .21, respectively). Similarly, since N for these unstudied objects reflects a "possibility feeling" for a reason other than pre-exposure, (e.g., similarity to a real object encountered pre-experimentally, see Marsolek & Burgund, 2005), by subtracting N estimations for unstudied objects from N estimations for studied objects, we can obtain an estimation of the perceptual fluency effect capitalized by the non-analytic strategy (.07, .11, .08, and .11, respectively). We computed an ANOVA with these Strategic Memory use estimations (A vs. N) and studied object Rotation in these Experiment 1A data. In line with our hypotheses, this analysis revealed a significant advantage for A estimation over N estimation, suggesting that the object decision task in this study involved more A-based memory responses than N-based memory responses ($F(1, 47) = 7.64$, $p = .008$). Furthermore, we observed a significant Strategy × Rotation interaction ($F(3, 144) = 3.124$, $p = .03$), indicating a linear Rotation effect on A-based memory estimation ($F(1, 47) = 5.974$, $p = .02$) but not on N-based memory estimation ($F = 1.4$).

Another complementary explanation of the dissociation between object decision priming and explicit recognition might be that the analytic strategy leads to different forms of strategic control over retrieval under both conditions. First, with the explicit recognition instruction, participants were informed of the rotation manipulation and could attempt to recognize objects by applying intentional mental rotation. The standard finding with mental rotation is that response times increase linearly with increasing rotation distance (Shepard & Cooper, 1982; Tarr, 1995), as was observed in recognition response times in our two experiments. During the object decision task, participants received no information about either rotation manipulation or prior episodes. So the principal purpose of analytic, part-based processing in this task is likely to be the simple search for relevant features directly available from the test object, and not the retrieval of the prior experience. In this context, parts of objects might "accidentally" act as valid retrieval cues, but perhaps only when the study and test versions are very similar. In this case only, this strategy might induce unintentional conscious remembering of discriminating details. In addition, the diversified encoding tasks used ensure that the objects can be encoded in many different ways, with many kinds of encoded information, access to which might be affected differently by object transformations at the test time. Although the explicit component of object decision priming might depend only on retrieval of the specific local configurations associated with whether an object is possible or impossible, recognition tasks might depend on this same information but also on other aspects of the encoded representation object, such as semantic elaborations (e.g., "This object looks like a spaceship.").

To summarize, we proposed that first, participants might perceive a non-analytic strategy as unreliable for object decisions. Thus, in this study, we assumed that the object decision task would motivate participants to focus on specific, local aspects of the stimulus to a greater extent than would the recognition task and, above all, that the liking judgment would do this. In addition, this part-based strategy, at least when it causes an unintentional or involuntary remembering of some aspect of prior episodes, seems more view-dependent than a whole-based memory strategy, as suggested by the mere exposure findings. In order to further test this hypothesis, we decided to examine the influence of retrieval strategy on the liking, recognition and object decision conditions, from the same perspective as Whittlesea and Price (2001) or Ratcliff and McKoon (1995). Through these manipulations, we hoped to show that global and analytic strategies were responsible for the differential experimental manipulation (i.e., rotation and object type) effects. Our first step in this direction was to focus on the mere exposure effect and explicit recognition in Experiment 2. An immediate implication of our account is that we would have expected to replicate the view-independent performance by implementing instructions that encourage the use of a non-analytic strategy (Experiment 2A) and to reverse the pattern of results by using instructions that prompt an analytic strategy (Experiment 2B).

EXPERIMENT 2

Global / Analytic Liking and Recognition

In Experiment 2A, we used Whittlesea and Price's recognition instruction in order to induce non-analytic processing of the stimuli during the recognition judgment, thereby allowing participants to capitalize on the fluency advantage for studied objects over unstudied ones. We presented study and test stimuli in the same way as in Experiment 1. However, at the test phase, we falsely informed participants that none of the objects had been presented at the study phase, but that some items resembled studied items. In addition, participants were warned that these globally similar test items did not possess all the same distinctive parts as the related studied items. Thus, for each object, participants simply had to say whether *yes or no, the object resembled an object they had seen before*. In Experiment 1, participants had been able sometimes to attempt to isolate some distinctive parts composing a stimulus to see whether any of them acted as a cue for recalling details of the context in which the stimulus had previously been encountered. In this experiment, because they were falsely informed that these parts had been modified between the study and test phases, one would assume they would not attempt to isolate them. Indeed, this global resemblance instruction developed by Whittlesea and Price is intended to prompt participants to process items non-analytically because of their global similarity, and to experience a global feeling of fluency.

In Experiment 2B, participants received the same instructions as in Experiment 2A. However, for each "*Yes, the object is pleasant*" or "*Yes, the object resembles one I saw before*" response, participants were also instructed to justify their responses by pointing to the part of the objects which they thought was particularly pleasant or particularly similar (see Whittlesea & Price, 2001). As regards recognition, we assumed that in Experiment 1, analytic and non-analytic strategies might both be used not exclusively, but perhaps alternately. The analytic instructions could constitute one factor triggering exclusive use of part-based processing. If this instruction caused participants to process the stimuli analytically, and if analytic processing causes participants to experience less enhanced fluency, we should expect to observe a greater rotation effect on both recognition and mere exposure effect like for object decision priming in Experiment 1A.

Method

Twenty-eight undergraduate students from the University of Liège participated in Experiment 2A, and 28 in Experiment 2B. The materials and design were similar to those used in Experiment 1 except for Whittlesea and Price's recognition instructions, as explained above[4]. In Experiment 2B, the test objects were divided by a vertical and a horizontal line forming four quadrants. For each each "*Yes, the object is pleasant*" or "*Yes, the object resembles one I saw before*" response, participants were asked to justify their response by pointing to the quadrant that either seemed to be most similar (recognition task) or that made that stimulus particularly pleasant (liking task) in order to induce analytic processes.

Results and Discussion

Experiment 2A (Liking and Global Recognition): This experiment was identical to Experiment 1 except in the recognition instructions. Thus we performed the same steps in analyzing this experiment.

In the liking task, the 5 X 2 ANOVA showed a significant main effect for Test Status ($F(4, 108) = 3.340$, $p = .01$), but no other effect (all $Fs < 1$), similarly to Experiment 1B (see Table 3). The a-priori contrast test again showed that participants again gave significantly more liking responses for studied objects with 0°, 60°, and 180° study-to-test rotations than for unstudied objects, (all $Fs > 4.5$), but no significant mere exposure effect was observed for possible or impossible objects with a 120° study-to-test rotation (all $Fs < 1.6$). We again observed a marginal linear rotation effect ($F(1, 27) = 2.915$, $p = .09$). Thus we replicated the findings of Experiment 1B.

Concerning the proportion of recognition responses, the 5 X 2 ANOVA showed a significant main effect for Test Status on response proportion ($F(4, 108) = 4.5$, $p < .01$). This effect indicates a selection advantage for studied (Hits) over unstudied objects (FAs) in all Rotation and for the both Object Types (all $Fs > 22$) but, in contrast to Experiment 1, no significant linear rotation effect was noted on the proportion of Hit responses ($F= .008$).

INSERT TABLE 3 ABOUT HERE

An ANOVA with Task (Recognition vs. Liking), Object Type (Impossible vs. Possible) and Rotation condition (0°, ±60°, ±120°, 180°) was conducted on the proportions of recognition responses and of liked objects and revealed no significant interaction involving Rotation and Task (all $Fs < 1$), as in Experiment 1B.

Combined analysis of Experiments 1A and 2A: In order to find out whether recognition instructions significantly influenced the patterns of recognition performance, we computed an ANOVA on the recognition data from both experiments, including Object Type and Rotation as the within-subjects variable and type of recognition Instructions (Standard vs. Global) as the between-subjects variable. This analysis revealed a significant Type of Instruction × Rotation interaction on Hit response proportion ($p = .05$), showing that non-analytic instructions made recognition less sensitive to the effect of rotation.

Experiment 2A (Analytic Liking and Analytic Recognition): For the proportion of liked objects (see table 4), the 5 X 2 ANOVA showed a significant main effect for Test Status ($F(4, 108) = 3.992$, $p = .005$), but no other effects (all $Fs < 1$). In addition, the a-priori contrast test showed that participants produced significantly more liking responses for studied than unstudied objects only in the case of studied objects with 0° study-to-test rotation (for both object types, all $Fs > 4.7$). No significant mere exposure effect was observed for other rotation conditions (all $Fs < .1$). The results of Experiment 2B are very different from those of Experiments 1B and 2A. Indeed, it seems that the analytic liking instructions induced a rotation effect pattern very similar to that observed for the object decision priming in Experiment 1A.

Regarding explicit recognition, the 5 X 2 ANOVA showed a significant main effect for Test Status on the proportion of recognition responses ($F(4, 108) = 30.569$, $p < .001$), with a selection advantage for studied (Hits) over unstudied objects (FA) (all $Fs > 7$). A linear rotation effect was observed on Hit response proportions and on Hit RTs, for both Object Types taken together (all $Fs > 15$).

INSERT TABLE 4 ABOUT HERE

The ANOVA with Task, Object Type and studied objects Rotation was performed on the proportion of Hit recognition responses and liked studied objects and revealed a significant Task × Rotation interaction ($F(3, 78) = 4.035$, $p = .01$). This interaction indicated that, although analytic recognition was greatly affected by Rotation, the mere exposure effect was slightly more dramatically impaired.

Combined analysis of Experiments 1A and 2B: The results of Experiment 2B are very different from those of Experiments 1B to 2A, especially for the mere exposure effect. Indeed, it seems that the analytic liking instructions induced a rotation effect pattern very similar to that observed for the object decision priming in Experiment 1A. Consequently, in order to test directly the similarity of the effect of rotation on object decision priming and the mere exposure effect, we conducted an additional ANOVA on response proportion for the studied possible object data from both experiments (Experiment 1A and 2B) with Task (implicit vs. explicit) and Rotation condition as the within-subjects variable and Type of implicit measure (object decision vs. analytic liking) as the between-subjects variable. This analysis revealed a significant Task (implicit vs. explicit) × Rotation interaction ($p = .003$), but no significant interaction between the three factors ($F = 1.5$), showing that the differential rotation effects on implicit and explicit tasks were very similar in Experiments 1A and 2B. Although statistical comparisons could be an incomplete means of comparison, these results are consistent with the view that the discrepancy between object decision priming and the mere exposure effect results from a different strategic use of distinctive detail retrieval and global fluency.

In order to find out whether recognition instructions significantly influenced the patterns of recognition performance, we computed ANOVAs on the recognition data from both experiments, including Object Type and Rotation as the within-subjects variable and type of recognition Instruction (standard vs. analytic) as the between-subjects variable. This analysis revealed a significant Type of Instruction × Rotation interaction on Hit response proportion (F (3, 147) = 3.297, $p = .02$). The interaction on Hit response proportion showed that the analytic instructions made recognition more sensitive to the effect of rotation. Thus, non-analytic instructions reduced the influence of study-to-test rotation on recognition performance, and analytic instructions accentuated this influence. Nevertheless, analytic instructions produced less striking performance changes with explicit recognition than with the mere exposure effect. One first potential explanation could be that from the outset, the recognition condition prompts to some degree an analytic strategy, whereas the liking condition induces more exclusively a non-analytic strategy and thus would be more affected by analytic instruction. One second potential explanation could be that, with the explicit recognition instruction but not with the liking task, participants were informed of the rotation manipulation.

In Experiments 1 and 2, the mere exposure effect seems based on a kind of processing that generates memory information that is relatively resistant to study-to-test rotation. These findings clearly differ from the result pattern obtained by giving instructions that prompt an analytic strategy (Experiment 2B); here, the main finding was that the mere exposure effect is severely impaired by object rotation, since we observed a significant mere exposure effect only when objects were in the same orientation at the test and study phases, as was observed for object decision priming in Experiment 1A. This similarity of results for analytic mere exposure effect and object decision priming might confirm that the view-dependence of object decision priming is dependent on an exclusive use of an analytic approach. In order to test further this strategy hypothesis, we decided to induce the global retrieval strategy by instructional control in the object decision task in the next experiment.

EXPERIMENT 3

Global Object decision and Recognition

In this experiment, we used exactly the same procedure as in Experiment 1A. However, participants were warned at the test that some test items were similar in appearance to objects seen during the study phase but that some of these similar objects did not possess all the same critical features underlying the possible/impossible nature of the objects. In other words, we erroneously informed participants that objects that had been presented in the study phase in a possible version would sometimes be presented in an impossible version in the test phase, and vice versa. In Experiment 1A, participants might have attempted to respond to the object decision demand by more frequently using analytic processing, which could give them access to information that might operate as a cue for recalling relevant information (such as possible/impossible discrimination spontaneously performed during the encoding phase, Marsolek & Burgund, 2005). In this experiment, because they were falsely informed that these distinctive features had been modified, they were not expected to attempt to retrieve them. Regarding the recognition task, participants simply had to say whether, yes or no, the object resembled an object they had seen before, as in Experiment 2A.

Method

The materials and design were similar to those used in Experiment 1A except for the object decision and recognition instructions, as explained above. Thirty undergraduate students from the University of Liège acted as volunteers.

Results and Discussion

With regard to correct responses in the object decision task (see Table 5), the 5 X 2 ANOVA showed a significant main effect for Object Type with an advantage for possible objects ($F(1, 29) = 15.808$, $p < .001$), a significant Test Status × Object Type interaction ($F(4, 116) = 3.742$, $p < .006$), but no Test Status effect ($F = .21$). The a-priori tests indicated significant priming on accuracy rates for possible objects whatever the study-to-test rotation (all $Fs > 6.1$). Secondly, we observed that participants gave significantly less accurate responses for studied impossible objects than for unstudied ones in the 0° condition ($F(1, 29) = 4.592$, $p = .04$), and a very slight effect was observed in the 60° condition, although not significantly ($F(1, 29) = 2.922$, $p = .098$). There was no significant effect in other conditions (all $Fs < 1.7$). Finally, we noted no significant linear effect of Test Status on the proportion of correct responses for either possible or impossible objects (all $Fs < .5$). Regarding RTs for correct responses, we observed a priming effect for possible objects in the 0°, 60° and 180°

rotation conditions (all *Fs* > 4.6). Nevertheless, we did not observe a priming effect for impossible objects (all *Fs* < 1.5). No priming was noted for possible objects with 120° rotation ($F = 0.4$). Finally, contrast tests showed no significant linear rotation effect on RTs for both possible and impossible objects taken separately (all *Fs* < .5)[5].

In order to examine whether this non-analytic priming task involves distinctive detail retrieval (capitalized by the analytic strategy) more than fluency influence (capitalized by the non-analytic strategy) as in Experiment 1A, we calculated the contribution of these two strategy-based memory responses using the process dissociation procedure described earlier. We computed ANOVAs with the two kinds of Strategic Memory use estimation (*A* vs. *N* estimations) and the Rotation condition on studied items. Unlike Experiment 1A, this analysis revealed that *A* estimations did not have a significant advantage over *N* estimations ($F = .001$; for studied 0°, ±60°, ±120°, and ±180°, respectively; *A* estimations were .23, .17, .16 and .15; *N* estimations were .16, .19, .19, and .18). Nonetheless, this result also suggested that our non-analytic object decision instructions did not completely eliminate the contribution of distinctive detail retrieval to performance. The reason was that participants probably adopted an analytic strategy not principally intentionally to remember information from prior episodes (that was prevented by the analytic instructions) but simply in order to search for critical features directly available from the test object. Consequently, even if the global object instructions reduce the reliance on analytic processing, they do not totally suppress the perceived usefulness of this strategy to participants in the object decision task. Finally, we again observed a slight linear rotation effect on *A* estimation ($F(1, 31) = 3.517$, $p = .07$) but not on *N* estimation ($F = .12$). Thus, these results support the assumption that the difference in the rotation effect between the mere exposure effect and object decision priming results from the use of different strategies to perform the object decision and the liking task. We therefore suggest that the large rotation effect observed in Experiment 1A and the absence of priming for impossible objects (Experiment 1A) result from using an analytic strategy.

With regard to responses in explicit Recognition, ANOVAs showed only a significant main effect of Test Status on the proportion of recognition responses (see Table 5) (respectively, $F(4, 116) = 31.199$, $p < .001$; other effects, all $Fs < .5$). This effect indicates a selection advantage for studied (Hits) over unstudied objects (FAs) in the case of all studied objects, whatever the Rotation or the Object Type (all $Fs > 34.0$), but no significant linear rotation effect ($F < 1$).

INSERT TABLE5 ABOUT HERE

Differences between the orientation effect on object decision and recognition tasks were evaluated by 2 × 4 ANOVA (Task × studied object Rotation × Object Type). This analysis revealed a main effect for Object Type and a Task × Object Type interaction (all $Fs > 9.1$), but no significant interaction between Task and Rotation conditions, or any other effects (all $Fs < .5$). Thus, unlike in Experiment 1A, these findings showed that the effect of rotation on the object priming effects and recognition was very similar.

Thus we noted significant object decision priming and recognition whatever the study-to-test rotation. Secondly, participants gave significantly less accurate responses for studied impossible objects than for unstudied ones in the 0° condition ($F(1, 29) = 4.592$, $p = .04$), and a very slight effect was observed in the 60° condition, although not significantly ($F(1, 29) = 2.922$, $p = .098$).

In conclusion, it appeared in Experiment 3 that non-analytic instructions in the object decision task strikingly reduced the differential effect of rotation on explicit recognition and object decision priming. However, it seems that analytic processing use is still significant. The aim of Experiment 4 was thus to eliminate analytic processing more drastically by using a deadline procedure.

EXPERIMENT 4

Object decision and Recognition with Deadline

We attempted to eliminate analytic processing by imposing a deadline procedure similar to that proposed by Ratcliff and McKoon (1995, Experiments 2 and 3; see also Williams & Tarr, 1997). Our reasoning was that analytic processes requiring more resources than global processing could be slower by comparison and thus short response periods would potentially prevent participants from searching for specific information, but would prompt participants to use a simple global impression.

Method

Thirty-two University of Liège undergraduate students participated in Experiment 4. We used the same stimuli and procedure as in Experiment 1A. At the beginning of the experimental session, participants were given practice in responding to a deadline. For this practice, 50 pictures of faces (25 women and 25 men) were displayed, one face at a time, on the screen. Participants were asked to decide on the sex of each face. A row of asterisks was displayed underneath the faces for 600 ms. Participants were instructed to try to respond based on their first impression as quickly as possible before the asterisks disappeared.

After the sex-decision practice session, the study phase for the three-dimensional objects was presented, followed by the test phase, as in Experiment 1A. The test trials were preceded by six practice objects in order to familiarize participants with the possible/impossible discrimination task; they made decisions and received oral feedback. Then there were twelve more practice objects with asterisks that were displayed underneath the object for 600 ms in order to train subjects again to respond on their first impression within this period.

Results and Discussion

Differences between the effect of orientation on object decision priming and recognition were evaluated by an ANOVA with Task, Object Type and Rotation condition on the proportion of correct responses for studied objects. Except for a main effect for Object Type, and an Object Type × Task interaction (all *Fs* > 25), this revealed neither significant interaction between these tasks and the Rotation condition, nor any other effect (all *Fs* < 1).

INSERT TABLE 6 ABOUT HERE

For the object decision task, an ANOVA showed a significant main effect for Object Type, with a significant advantage for possible objects ($F(1, 31) = 101.496$, $p < .001$) and a Test Status × Object Type interaction ($F(4, 124) = 6.870$, $p < .001$), but no main effect for Test Status ($F = 0.2$). Interestingly, significant priming on accuracy rates (i.e., more correct responses for studied objects than for unstudied distractors) was noted for possible objects in all rotation conditions (all *Fs* > 6). Conversely, we observed that the probability of giving an incorrect response to an impossible object (i.e., responding "possible" to an impossible object) was increased by previous study in all rotation conditions (i.e., there were significantly fewer accurate responses for studied objects than for unstudied distractors; all *Fs* > 8.8). Finally, contrast tests showed no significant linear Rotation effect on the proportion of correct responses for both possible and impossible objects (all *Fs* < .3).

Furthermore, with the deadline, the tendency to respond "possible" was significantly greater for impossible than for possible objects. Indeed, the proportion of "possible" responses were .74 and .64 for 0° studied and for unstudied possible objects, and the proportion of incorrect "possible" responses were .45 and .32 for 0° studied and for unstudied impossible objects (mean difference between 0° studied and unstudied objects: respectively, .13 and .10, $F(1, 31) = 270.538$, $p < .001$). In Experiment 1A, without a deadline, some analytic processes might have influenced the decision-making process: the tendency to respond "possible" was .03 for impossible and .09 for possible objects (although not significantly so) in the 0° condition, in which a priming effect was observed. In addition, participants made significantly more "possible" responses with a deadline than without one

($F(1, 74) = 9.954$, $p = .002$).

Consequently, in order to highlight the fact that the priming task with a response deadline involves less critical or contextual information retrieval (capitalized by the analytic strategy), we again calculated estimations of the analytic and non-analytic access of memory cues by the dissociation procedure described above. We computed an ANOVA with these kinds of strategic processing (*A* vs. *N* estimations) and Rotation on studied objects. Unlike in Experiments 1A and 3, this analysis revealed a significant advantage for *N* estimations (non-analytic, fluency-based memory responses) over *A* estimations (analytic, distinctive-part-based memory responses). For studied objects with 0°, ±60°, ±120° and 180° rotation, respectively, *A* estimations were: .13, .14, .13 and .07; *N* estimations were: .23, .22, .21, and .21 ($F(1, 27) = 9.469$, $p = .004$). The deadline procedure thus seems to reduce sufficiently the use of analytic memory cues. In addition, we again observed a rotation effect on *A* estimations ($F(1, 27) = 4.65$, $p = .04$) but not on *N* ($F = .309$).

For the proportion of recognition responses, an ANOVA showed a significant main effect for Test Status ($F(4, 124) = 30.084$, $p < .001$) but no other significant effect (all $Fs < 1.1$). Contrast tests showed no significant linear effect of Test Status on the proportion of Hit responses for either possible or impossible objects ($F < 1.5$).

Thus, we observed that the deadline procedure increased the tendency of the non-analytic instruction effect with, on the one hand, a striking reduction in the differential effect of rotation on explicit recognition and object decision priming, and on the other hand, more ‘possible’ responses for studied impossible objects than for unstudied ones.

General Discussion

In this study, we have shown that participants in liking and object decision tasks, but also in recognition tasks, may adopt different decision strategies that determine the precise way in which prior encounters with stimuli influence current performance. We proposed that, in the liking task, by default, participants would adopt to a large extent a non-analytic strategy whereby processing fluency is experienced and attributed to liking (producing a mere exposure effect, Whittlesea & Price, 2001). On the other hand, we assumed that in the object decision task – at least when participants could take some time to respond – they would preferentially choose an analytic strategy in which the stimulus is analyzed into components. Finally, analytic and non-analytic strategies might be used in synergy in recognition tasks.

In the context of a recognition task, the analytic strategy determines whether part of the stimulus acts as a cue for recalling details of the context in which the stimulus has been previously encountered. On the other hand, in the context of an object decision task, this strategy might consist of a simple strategy in an attempt to isolate one stimulus component to see whether any of them constitutes a possible or impossible configuration. Whatever the purpose of this kind of strategy, the resulting part-based processing at the time of testing seems to block the experience of a global feeling of fluency (as demonstrated by Whittlesea & Price). We therefore assume that these different strategies, suggested by Whittlesea and Price, may potentially account for the number of dissociations observed in the literature between the mere exposure effect and recognition (e.g., Bonnanno & Stilling, 1986; Kunst-Wilson & Zajonc, 1980; Mandler, Nakamura, & van Zandt, 1987; Seamon et al., 1995, 1997); between the priming effect and recognition (e.g., Cooper et al., 1992; Hamann & Squire, 1997; Schacter, Copper, & Delaney, 1990; Stark & Squire, 2000; Wagner et al., 1997, 1998); and also between priming and the mere exposure effect (e.g., Seamon et al., 1995; Butler, Berry, & Helman, 2004).

We provided direct experimental evidence of the fundamental role of the strategies employed in such tasks. In Experiment 1, we found that a prior encounter with the objects affected recognition, liking and object decision tasks differently when the objects were subjected to study-to-test rotation. More specifically, while significant object decision priming was not observed for larger orientation differences (i.e., studied object with ±60°, ±90°, ±120°, or 180° study-to-test rotation), recognition performance continued to decline gradually following 60° through 180° orientation shifts and, although slightly reduced by this stimulus transformation, a significant mere exposure effect was also observed following ±60°, ±90°, and 180° study-to-test rotation. Moreover, in contrast to object decision priming, we observed a significant mere exposure effect (like Seamon et al., 1995, 1997) and explicit recognition for impossible objects. Taken alone, this result could support the notion that different types of memory representation are responsible for performance in these three tasks. Instead, we explored an account whereby enhanced perceptual fluency (which can be experienced even for rotated studied objects) might be used when people adopt a non-analytic strategy in all three tasks, whereas the remembering of distinctive detail (which could be more sensitive to study-to-test rotation), could be used to make possible object, liking or recognition decisions when people adopt an analytic strategy.

We tested this account by implementing analytic or non-analytic instructions (Experiments 2 and 3), and by giving a short response deadline in order to prevent the retrieval of distinctive information (Experiment 4). Taken together, the results of these experiments support our hypothesis: when a non-analytic strategy was experimentally prompted for explicit recognition and object decision priming, we found a relatively similar tendency in all three tasks, with an overall lesser impact of study-to-test rotation and with a pre-exposure effect on decisions about impossible objects. Conversely, when an explicit analytic strategy was induced for explicit recognition and mere exposure effect, we found an impact of rotation on the mere exposure effect very similar to that observed for object decision priming, and explicit recognition was also slightly more affected. These findings support the notion that analytic and non-analytic processing are two strategies for processing stimuli that can used in both implicit and explicit tasks and that can generate qualitatively different memory cues (Whittlesea & Price, 2001). In addition, this result suggests that, although analytic and non-analytic strategies may be used in synergy as they probably were in this study under recognition condition (in which strategy manipulation affected performance to a lesser extent), the simplicity and subjectivity of the liking task might motivate people to adopt preferentially a non-analytic heuristic that recruits few resources. Conversely, the objective nature of the task, and also the perceived irrelevance of fluency as a cue for the possibility decision, might prompt people to adopt a part-based processing strategy more often in the object decision task condition.

Moreover, these results corroborate the notion introduced by Ratcliff and McKoon (1995) that object decision priming is largely "contaminated" by specific information retrieval (see also, Marsolek & Burgund, 2005; Williams & Tarr, 1997). Indeed, by introducing manipulations that can eliminate analytic strategy and thus these retrieval processes, we obtained a strikingly different performance pattern. More specifically, we used non-analytic object decision instructions that falsely informed participants that retrieving information about prior episodes would not be useful (Experiment 3). As a result, firstly, an object decision priming effect appeared for impossible objects (in the sense that participants showed a tendency to incorrectly respond "possible") and secondly, object decision priming was less or not at all affected by large study-to-test orientation shifts, as observed for the mere exposure effect. These results were even stronger when we imposed a short deadline on response times (Experiment 4).

We interpreted these findings as reflecting the fact that enhanced fluency, due to pre-exposure, led to a tendency to respond "possible" for both possible and impossible objects in the object decision task (which can be opposed for impossible objects by analytic processes that act to produce the correct "impossible" answer). This same fluency might be attributed also to object pleasantness in the liking task and to object familiarity in the recognition task.

Along these lines, several authors have argued that perceptual fluency plays an important role in various decision tasks and produces various subjective feelings, such as liking (e.g., Bornstein & D'Agostino, 1992; Seamon et al., 1983a,b), recognition (e.g., Gardiner, 1988; Jacoby & Dallas, 1981; Mandler, 1980; Rajaram, 1993; Verfaellie & Cermak, 1999), but also duration (Masson & Caldwell, 1998), truth (Begg & Armour, 1991; Reber & Schwarz, 1999), normative word frequency (Toth & Daniels, 2002), and stimulus clarity (Goldinger, Kleider, & Shelley, 1999). According to the fluency-attribution heuristic developed over the last 20 years, these feelings are considered to be based either on the misattribution of enhanced fluency to the dimension made salient by the test (e.g., pleasantness, duration judgments) or on the correct attribution to the real source of the facilitation (i.e., previous encounter). From this perspective, the mere exposure effect constitutes an affective misattribution of enhanced fluency due to prior repetition. We suggested that the "possibility" feeling also results from a misattribution process. More specifically, according to this fluency-attribution account, if participants adopt a non-analytic heuristic, in the sense that they process a stimulus as a whole rather than analyzing it by its parts, and if the whole item engenders a feeling of fluent processing, then an attribution process is recruited to find a suitable dimension in the environment (e.g., possibility, pleasantness, familiarity) to which that fluent processing can be attributed. Thus, we do not think that the possibility bias effect is the result of an inevitable decision bias to consider a fluent object as possible. Rather, we assume that fluent reprocessing at test time resulting from quickly encoded perceptual information about three-dimensional objects (general configuration of features, Ratcliff & McKoon, 1995; partial possible configuration, Williams & Tarr, 1997; category-diagnostic features or whole-based information, Marsolek & Burgund, 2005) can produce various feelings such as pleasantness (Seamon et al., 1995, 1997), symmetry (Liu & Cooper, 2001), possibility (Marsolek & Burgund, 2005; Ratcliff & McKoon, 1995; Williams & Tarr, 1997) and familiarity-based recognition.

In addition, regarding the absence of object decision priming for impossible objects, this study might reconcile the possibility bias theory (Ratcliff & McKoon, 1995) with another point of view developed by Carrasco and Seamon (1996). These authors showed that when possible and impossible objects are equated for visual complexity, object decision priming occurs for both object types. Thus, the absence of priming might occur when impossible objects are visually complex. We suggested that the analytic processing adopted by participant in object decision task could be less efficient for complex object rich in details whereas non-analytic processing which focuses on global form of object could be not. In agreement with this assumption, it has been demonstrated that mere exposure effect which depends on global processing is not influenced by complexity of stimuli (Bornstein, 1989).

Finally, the central question addressed in this article did not concern whether a single or a multiple memory store could underlie, on the one hand, object decision priming, the mere exposure effect and explicit recognition (see Marsolek & Burgund, 2005; Ratcliff & McKoon, 1995; Rouder, Ratcliff, & McKoon, 2000; Seamon et al., 1995, 1997; Williams & Tarr, 1997, for a more direct approach to these questions) and, on the other hand, view-independent and view-dependent performance. Rather, we argued that task requirements may be determining in generating different results in studies of implicit and explicit memory performance. We suggest that, instead of directly interpreting the nature of potential representations or processes from differential performance in different memory tasks, sometimes the question of the influence exerted by the various task demands may be more informative (see also Liu & Cooper, 2001).

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Notes

1. For example, *Participant 1*: set 1 = studied 0°, set 2 = studied –60°, set 3 = studied +120°, set 4 = studied 180°, set 5 to 8 = unstudied distractors; *Participant 2:* set 7 = studied 0°, set 8 = studied +60°, set 5 = studied –120°, set 6 = studied 180°, and set 1 to 4 = unstudied distractors, etc.

2. 5 × 2 × 2 ANOVAs [Test Status, Task Order, (counter)clockwise] performed on response proportions and RT data in all experiments showed no main effect or interaction involving the Task Order or (counter)clockwise factors. Therefore, all the analyses reported in this study were performed on data collapsed over the task order and (counter)clockwise conditions.

3. Mean RTs for possible objects were 944, 1266, 1263, 1276, and 1266 ms in the 0° , 60° , 120°, 180° , and unstudied items respectively. Mean RTs for impossible objects were 1251, 1259, 1279, 1240, and 1263 ms. Anova showed a significant main Test Status effect and a significant Test Status × Object Type interaction (respectively, $F(4, 188) = 23.283$, $p < .001$; $F(4, 188) = 16.398$, $p < .001$), but no significant main Object Type effect ($F < 2$).

4. Full instructions used for Experiments 2 and 3 are available at www.ulg.ac.be/neuropsy/mere exposure effect.

5. Mean RTs for possible objects were 1029, 1033, 1041, 1070, and 1083 ms in the 0°, 60°, 120°, 180° , and unstudied items respectively. Mean RTs for impossible objects were 1064, 1073, 1061, 1081, and 1086 ms. ANOVA showed a significant main effect for Test Status, a slight but non-significant Object Type effect, and no Test Status × Object Type interaction (respectively, $F(4, 116) = 2.612$, $p = .03$; $F(1, 29) = 3.008$, $p = .094$, $F = 0.5$).

Author notes.

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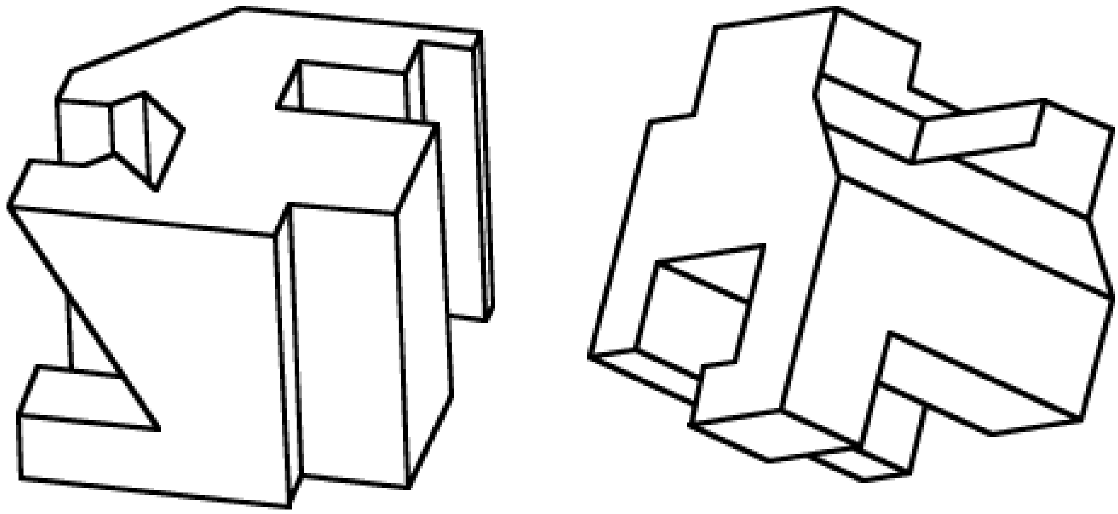
Figure Titles

Figure 1. Examples of stimuli used in the experiments. The left figure depicts a possible object; the right figure depicts an impossible object for studied objects as function of rotation and for unstudied objects (distractors).

Figure 2. Example of study-to-test rotation



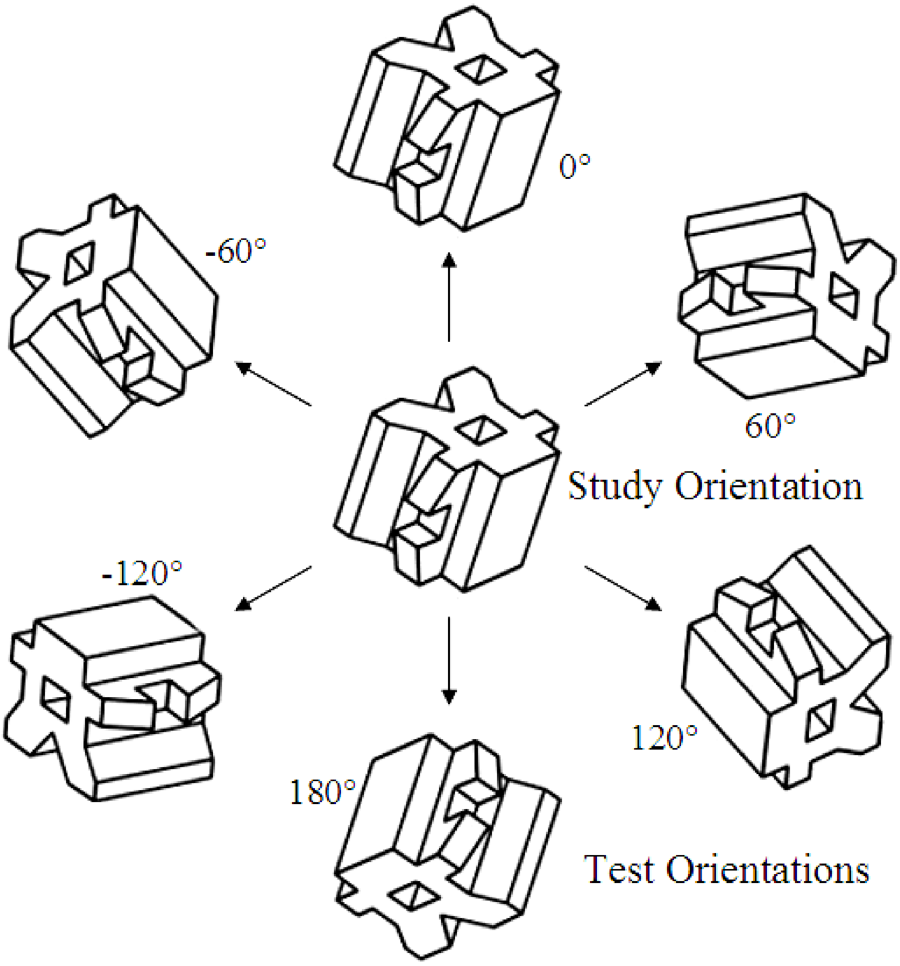


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Table 1.

Accuracy rates in object decision task (OD), Reaction Times un object decision task (OD RTs) and Recognition responses proportion (REC) for studied objects and for unstudied objects.

		Studied Objects				
Task	**Type**	0°	60°	120°	180°	**Unstudied Objects**
OD	Possible	.89 (.14)	.81 (.17)	.83 (.17)	.84 (.14)	.80 (.16)
	Impossible	.77 (.18)	.77 (.21)	.79 (.22)	.78 (.19)	.80 (.16)
OD RTs	Possible	943 (206)	1266 (247)	1262 (236)	1276 (211)	1265 (247)
	Impossible	1251 (226)	1258 (237)	1278 (239)	1252 (262)	1262 (180)
REC	Possible	.83 (.22)	.65 (.22)	.66 (.21)	.63 (.23)	.34 (.22)
	Impossible	.80 (.24)	.65 (.23)	.64 (.22)	.62 (.23)	.28 (.25)

Notes. Standard deviations are in parentheses.

Table 2

Means of Liked objects (LIK) and Recognition (REC) responses proportion for studied objects as function of rotation and for unstudied objects (distractors).

		Studied Objects				
Task	**Type**	0°	60°	120°	180°	**Distractors**
LIK	Possible	.60 (.27)	.50 (.20)	.47 (.27)	.50 (.16)	.41 (.16)
	Impossible	.53 (.21)	.50 (.31)	.46 (.25)	.52 (.21)	.37 (.15)
REC	Possible	.84 (.22)	.63 (.22)	.66 (.22)	.65 (.23)	.33 (.18)
	Impossible	.89 (.21)	.68 (.20)	.69 (.23)	.66 (.24)	.33 (.18)

Notes. Standard deviations are in parentheses.

Table 3

Means of Liked objects (LIK) and non-analytic recognition (*No* REC) responses proportion for studied objects as function of rotation and for unstudied objects (distractors).

		Studied Objects				
Task	**Type**	0°	60°	120°	180°	**Distractors**
LIK	Possible	.63 (.28)	.54 (.25)	.45 (.25)	.52 (.33)	.36 (.27)
	Impossible	.57 (.31)	.55 (.26)	.47 (.30)	.54 (.34)	.41 (.27)
No REC	Possible	.70 (.27)	.66 (.27)	.65 (.28)	.70 (.20)	.34 (.25)
	Impossible	.65 (.28)	.69 (.25)	.63 (.26)	.66 (.18)	.33 (.26)

Notes. Standard deviations are in parentheses.

Table 4

Means of analytic liking (*An* LIK) and recognition (*An* REC) responses proportion for studied objects as function of rotation and for unstudied objects (distractors).

		Studied Objects				
Task	**Type**	0°	60°	120°	180°	**Distractors**
An LIK	Possible	.58 (.32)	.40 (.27)	.45 (.35)	.43 (.23)	.43 (.29)
	Impossible	.58 (.29)	.38 (.30)	.41 (.30)	.40 (.31)	.40 (.31)
An REC	Possible	.84 (.18)	.68 (.27)	.59 (.27)	.45 (.34)	.29 (.26)
	Impossible	.87 (.17)	.73 (.23)	.64 (.28)	.48 (.37)	.35 (.36)

Notes. Standard deviations are in parentheses.

Table 5

Means of correct responses proportion in non-analytic Object Decision task (*No* OD) and non-analytic Recognition (*No* REC) responses proportion for studied objects as function of rotation and for unstudied objects (distractors).

		Studied Object				
Task	**Type**	0°	60°	120°	180°	**Distractors**
No OD	Possible	.73 (.13)	.72 (.15)	.72 (.14)	.70 (.10)	.60 (.10)
	Impossible	.58 (.20)	.60 (.18)	.61 (.23)	.62 (.23)	.68 (.15)
No REC	Possible	.67 (.23)	.65 (.22)	.66 (.22)	.66 (.24)	.29 (.24)
	Impossible	.65 (.24)	.68 (.26)	.63 (.24)	.63 (.23)	.23 (.24)

Notes. Standard deviations are in parentheses.

Table 6

Means of correct responses proportion in Object Decision task (OD) and Recognition (REC) responses proportion for studied objects as function of rotation and for unstudied objects (distractors).

		Studied Object				
Task	**Type**	0°	60°	120°	180°	**Distractors**
OD	Possible	.74 (.11)	.73 (.15)	.74 (.11)	.74 (.09)	.64 (.09)
	Impossible	.55 (.15)	.55 (.15)	.53 (.24)	.54 (.15)	.68 (.14)
REC	Possible	.68 (.23)	.64 (.21)	.60 (.26)	.64 (.23)	.30 (.27)
	Impossible	.66 (.25)	.63 (.25)	.61 (.22)	.60 (.22)	.24 (.22)

Notes. Standard deviations are in parentheses.