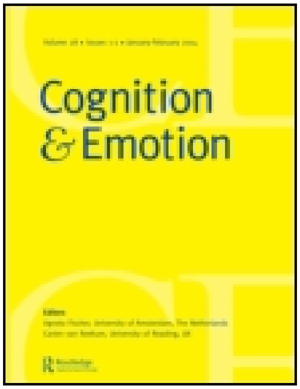

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Warmth of familiarity and chill of error: Affective consequences of recognition decisions

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Warmth of familiarity and chill of error: Affective consequences of recognition decisions

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The present research aimed to assess the effect of recognition decision on subsequent affective evaluations of recognised and non-recognised objects. Consistent with the proposed account of post-decisional preferences, results showed that the effect of recognition on preferences depends upon objective familiarity. If stimuli are recognised, liking ratings are positively associated with exposure frequency; if stimuli are not recognised, this link is either absent (Experiment 1) or negative (Experiments 2 and 3). This interaction between familiarity and recognition exists even when recognition accuracy is at chance level and the "mere exposure" effect is absent. Finally, data obtained from repeated measurements of preferences and using manipulations of task order confirm that recognition decisions have a causal influence on preferences. The findings suggest that affective evaluation can provide fine-grained access to the efficacy of cognitive processing even in simple cognitive tasks.

Keywords: Preferences; Recognition; Mere exposure; Affect; Familiarity.

Our everyday experiences and the works of psychologists tell us that our choices can influence our preferences. All things being equal, in the face of uncertain decisions we like the things we choose more than the things we reject (Brehm, 1956); arguments we select to prove our point seem more valuable than the ones we ignore (Simon, 2004); and chosen colleges seem to be more attractive than the rejected ones (Lyubomirsky & Ross, 1999). In general, there seems to be a post-decisional "spread of alternatives", with chosen items becoming more attractive and non-chosen items becoming less attractive (e.g., Mather, Shafir, & Johnson, 2000, 2003; Shamoun & Svenson, 2002; Simon, Krawczyk, & Holyoak, 2004; Svenson & Benthorn, 1992). The evidence referred to above is based entirely upon complex, real-life decision making. Thus, it is unclear whether such findings generalise to studies involving simpler tasks, for example, recognition, categorisation, or visual search.

The fact that decision effects have been little researched in simple tasks intuitively makes sense: In social and economic decisions the changes in preferences seem to be constrained to those situations where there is a conflict of values. For example, compared to one job offer, another can promise a good salary but minimal time off for

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vacation or fewer opportunities for promotion. As there is no obvious conflict of values in simple tasks, why should there be changes in liking of alternatives?

The present research investigated one specific example of post-decisional preferences, namely, the influence of recognition decision—have I seen it before or not?—on subsequent preferences. Our thesis is that, like more complex decisions, recognition decisions involve choosing between competing hypotheses (Allakhverdov & Gershkovich, 2010; Bar & Neta, 2008; Bruner, 1957). This process results in positive affect when the chosen hypothesis is confirmed, and in negative affect when it is rejected. Two existing alternative theoretical accounts—the fluency attribution model and the uncertainty reduction model—make different predictions with regard to the recognition–preference relationship.

The predictions of all three accounts were tested in a meta-analysis of previously published data and in three novel experiments.

Hypotheses testing model

It is now widely acknowledged that one of the most persistent principles of operation for our brain is prediction testing (Allakhverdov & Gershkovich, 2010; Bar & Neta, 2008; Bruner, 1957; Clark, 2013; Gregory, 1970; Hohwy, 2012). The model proposed here is based on the idea that affect indicates accuracy of the predictions made by our brain. These predictions, or hypotheses, can be relatively simple, such as "The object I see is an apple", or more elaborate, "I should go to work now because I will be able to escape traffic jams". Even in absence of external feedback the accuracy of predictions can be estimated on the basis of their consistency, that is, whether they are in agreement with predictions made on the basis of other data or using a different sort of analysis.

For example, if an object smells like an apple, looks like an apple, and we are told that it is an apple, then those predictions are accurate, because there are no inconsistencies between them.[1] Consequently, because consistency indicates accuracy, such predictions will be reinforced by positive affect. Conversely, if the object looks like an apple but smells like beef, and we are told that it is a cucumber, then the predictions are inconsistent, and we will experience negative affect. In sum, this model holds that accuracy of predictions is reinforced, positively or negatively, by affective feedback (cf. Ramachandran & Hirstein, 1999). This approach is consistent with neurophysiological data on error-monitoring: Negative affect is correlated with greater error-related negativity (ERN), a negative deflection on electroencephalography observed after approximately 60–100 ms of making an error (Chiu & Deldin, 2007; Hajcak, McDonald, & Simons, 2003, 2004; Holmes & Pizzagalli, 2008; Luu, Collins, & Tucker, 2000).

Although the present model is not domain-specific, it can be used to predict the dynamics of preferences in the recognition task. The hypothesis testing model suggests that affective evaluation of an object in relation to its objective familiarity[2] and recognition will be determined by three components that can be linked to the pre-decisional, decisional and post-decisional stages of a recognition task. Of particular relevance to the current research is the third, post-decisional, stage. However, all three should be accounted for in order to correctly describe the complex interaction of objective familiarity, recognition and affect. Thus, all three stages are outlined below.

The pre-decisional stage

First, even before we engage in a recognition task, we need to perceive the stimulus; in other words, both during the initial learning phase of the experiment and during the recognition phase we have to decide "what is this object?" The

[1] These predictions, of course, can contradict real data, as when we have an elaborated hallucination, but we will not know it.

[2] The author uses the operational definition of "objective familiarity" as a total time of previous processing of an object starting with zero. This definition includes both novel and old stimulus in a single continuum.

hypotheses testing model holds that this process consists of making predictions based on our previous experience and on the perceptual data available to us. The more familiar an object is to us, the easier it is to make correct predictions about it. Thus, the number of correct predictions about an object will increase as our familiarity with that object increases. In turn, liking will also increase. In contrast, when we are forced to continue our interaction with an object but cannot make any novel and correct predictions about it, we will begin to dislike it. This dynamic, determined by the ratio of successful to unsuccessful novel predictions, has an inverted U-shaped function (Figure 1A, dotted line), and has been observed in many previous studies (Berlyne, 1970; Heyduk & Bahrick, 1977; Lee, 2001; Nordhielm, 2002; Stang, 1975).

The decisional stage

Second, when we engage in a recognition task, we put forward a task-relevant hypothesis. The most natural candidate for such hypothesis is the hypothesis "I've seen this object", assuming that participants treat old items as "targets" that should be detected on the background of "non-targets", i.e., novel items (see Vilberg & Rugg, 2008, 2009, for a similar assumption). We decide whether the hypothesis is correct on the basis of the feedback we receive about hypothesis accuracy. In the present account, the feedback takes the form of positive or negative affect.

In an ideal situation, this feedback will be directly mapped to a decision, although it can be distorted by external constraints (for example, "Both objects look unfamiliar, but I still have to choose one") or by interference with "task-irrelevant" affect. It is hard to separate the affect arising from one source from the affect arising from other sources (Monahan, Murphy, & Zajonc, 2000; Murphy & Zajonc, 1993; Schwarz & Clore, 1983). Consequently, the recognition decision will be biased in favour of more positive objects (Figure 1A, grey lines). This bias is thoroughly documented in the existing literature (Baudouin, Gilibert, Sansone, & Tiberghien, 2000; Claypool, Hall, Mackie, & Garcia-Marques, 2008; Corneille, Monin, & Pleyers, 2005; Garcia-Marques, Mackie, Claypool, & Garcia-Marques, 2004, 2010; Lander & Metcalfe, 2007; Monin, 2003; Monin & Oppenheimer, 2005; Phaf & Rotteveel,

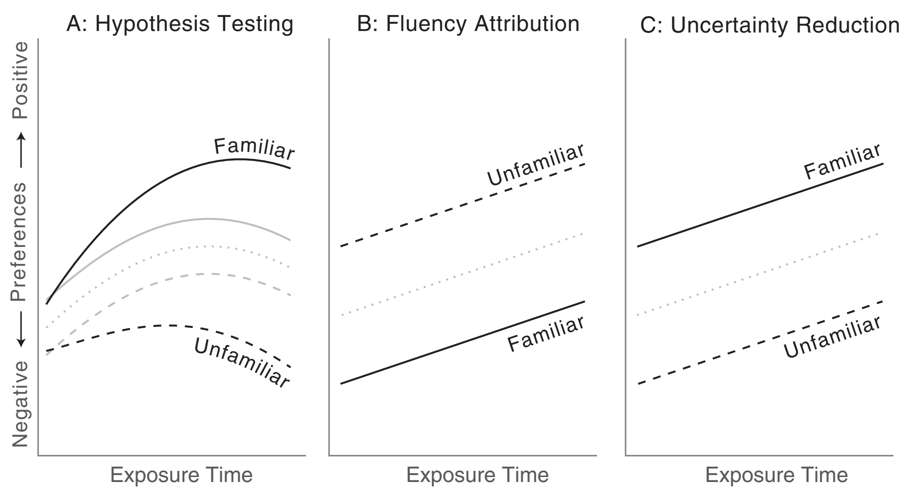


Figure 1. Predictions of hypotheses testing model, fluency attribution model, and uncertainty reduction model. Notes: Dotted lines represent average liking of object as a function of exposure time. Solid lines and dashed lines represent liking of recognised and non-recognised items, respectively. For hypotheses testing model grey solid and dashed lines represent liking of recognised and non-recognised items with respect to affective bias and without addition of post-decisional changes (these are included in order to clarify the construction of resulting function).

2005; Rotteveel & Phaf, 2007). The presence of such bias suggests that all stimuli, novel and old, should be liked more when they are recognised.

The post-decisional stage

Finally, according to the hypothesis testing model, the recognition decision itself is not the end point of analysis, but a prediction. Consequently, consistency of the decision with other available data is checked. The result of this check also serves as a source of positive or negative affect. Since incorrect answers are, by definition, more likely to contradict available data, they are related to a lesser degree of consistency between different hypotheses than are correct answers. The amount of data—which will be either consistent or inconsistent with the recognition decision—also increases with exposure time; thus, the effect of recognition decision on preference will be stronger for items that have longer exposure times (Figure 1A, black lines). For novel items and items presented for a very short time, any decision (i.e., both "Recognise" and "Don't recognise") will be equally supported by the data available, because the underlying distributions of memory strengths are similar (cf. Criss, 2009); thus the effect of any decision will be small. In contrast, for items with longer exposure times, a decision effect will be evident. Specifically, we predict that there will be a post-decisional change in the affective evaluations of objects in recognition tasks, as the decision will be tested for consistency with the available data.

Besides neurophysiological data on error monitoring (Hajcak et al., 2004; Holmes & Pizzagalli, 2008; Luu et al., 2000) our account of post-decisional changes in preferences is also consistent with predictions deriving from "cognitive dissonance" theory (Festinger, 1957; Harmon-Jones & Harmon-Jones, 2003, 2007; Harmon-Jones & Mills, 1999). Like the hypothesis testing model, "cognitive dissonance" theory supposes that inconsistent cognitions lead to negative affect, which, in turn, motivates post-decisional changes in preferences (Harmon-Jones, 2000). However, the dissonance model supposes a motivational conflict and has been applied mostly to the domain of social behaviour. To date, no systematic empirical research has examined whether the selection or rejection of hypotheses influences post-decisional preferences in simple cognitive tasks.

To sum up, the hypotheses testing model allows to explain different findings related to recognition decision, such as the dynamics of preferences as a function of previous exposure or affective biases, and to predict novel findings, namely, the interaction effect of recognition decision and objective familiarity on preferences. According to the hypotheses testing model, the difference between recognised and non-recognised objects on liking for those objects should be more pronounced under conditions of longer stimulus exposure.

Alternative accounts

Fluency attribution model

The fluency attribution model (Bonanno & Stillings, 1986; Bornstein & D'Agostino, 1992, 1994; Jacoby, Kelley, & Dywan, 1989; Seamon, Brody, & Kauff, 1983) suggests a two-step process for the explanation of the relationship between recognition, familiarity, and preferences:

1. The objective familiarity of an object leads to an increase in estimated fluency of processing.
2. This fluency is either correctly attributed to previous engagement with stimuli, or incorrectly attributed to other sources, including affect.

Support for this model comes largely from studies that manipulate ease of processing. Reber, Winkielman, and Schwarz (1998) varied the fluency of stimulus processing by presenting matching or mismatching primes before the stimuli, changing figure–ground contrast, and varying presentation duration. In all cases, the more fluently stimuli were processed, the more pleasant they were for participants. Winkielman and Cacioppo (2001) obtained similar results using not only subjective ratings but also electromyography, thereby confirming that the observed change in preferences is a genuine emotional reaction. In addition, many results from different empirical studies of preferences can be explained using the concept of fluency, including the effects of prototypicality (Halberstadt, 2006; Halberstadt & Rhodes, 2000; Winkielman, Halberstadt, Fazendeiro, & Catty, 2006), conceptual priming (Labroo, Dhar, & Schwarz, 2008; Lee & Labroo, 2004), and implicit learning (Gordon & Holyoak, 1983; Newell & Bright, 2001; Zizak & Reber, 2004).

The attribution step of the fluency attribution model has also been tested. Consistent with predictions, a meta-analysis by Bornstein and D'Agostino (1992) demonstrated that, compared to supraliminal exposures, subliminal exposures (which, supposedly, prevent participants from attributing their fluency to previous experience) led to greater liking. Bornstein and D'Agostino (1994) directly varied the information about previous exposure. They argued that if subjects know that they have seen the stimuli before, they will attribute their feelings to the familiarity of the stimuli and not to liking. In agreement with the predictions, when participants were told that they had already seen the stimulus, they liked it less compared to when they were told that they had not seen it before. However, a similar study conducted by Lee (1994) led to opposite results (see the description in the next section).

To sum up, there is strong support for the idea that ease of stimulus processing can increase both liking and recognition, and some support for the idea of attribution of fluency to preferences. Two predictions can be derived from the fluency attribution model: First, objective familiarity should increase preference ratings both for recognised and for non-recognised items; second, recognised items should be liked to a lesser extent than non-recognised items because part of the fluency is attributed to recognition. These predictions are schematically displayed in Figure 1B, and duplicate those made by Bornstein and D'Agostino (1994) and Lee (1994).

Uncertainty reduction model

The uncertainty reduction model is based on the works of Berlyne (1966, 1970). Berlyne's theory suggests that liking is dependent on the amount of arousal evoked by stimuli, with stimuli being liked best when they create a moderate amount of arousal. Novel—especially complex—stimuli are likely to "engender uncertainty, conflict, disorientation" (Berlyne, 1966, p. 285) and create excessive levels of arousal and negative affect. Levels of arousal gradually decrease over time, in turn leading to more positive stimulus appraisals. Lee (1994, 2001) suggested that both objective familiarity and recognition help to reduce uncertainty, which, in turn, leads to greater (perceived) stimulus attractiveness. The predictions of this model are schematically presented in Figure 1C, and duplicate those made by Lee (1994).

Using the same manipulations of the information about previous exposure as Bornstein and D'Agostino (1994), Lee (1994) has obtained the opposite results. That is, the "old" stimuli were evaluated as more pleasant than the "new" stimuli, thus supporting the predictions of the uncertainty reduction model. Later, Lee (2001) suggested that this discrepancy stems from the ambiguous nature of the instructions. To avoid such ambiguity, she studied the influence of participants' own recognition decisions (without any additional instructions concerning stimulus familiarity) and found support for the predictions of the uncertainty reduction model and no support for fluency attribution—both in analysis of previous studies and in her own experiments. Similar results have been obtained in two experiments by Chenier (2010).

However, the interpretation of the dependency between recognition and affect in the uncertainty reduction model is somewhat problematic. Why does recognition result in enhanced preferences? Using the notion of uncertainty reduction, one could suggest that any recognition decision should lead to increased liking, since any decision makes the situation more certain. Nevertheless, although empirical testing of this model has been limited, the data on recognition decisions seem to be more consistent with the uncertainty reduction model than the fluency attribution model.

To test the predictions of the three models, the remainder of this paper starts with a meta-analysis of studies on the relationship between recognition, objective familiarity, and preferences. The paper then moves on to present the results of three experiments that directly tested the predictions of the models.

META-ANALYSIS OF FAMILIARITY AND RECOGNITION EFFECT ON PREFERENCES

Method

To provide a first test of the proposed model, a meta-analysis of previous studies was conducted. Lee's (2001) paper served as a starting point for the literature search for papers that included both information about the effect of recognition on preferences and information about the effect of objective familiarity on preferences.[3] The available electronic databases (Scopus, Google Scholar, Web of Science) were then scanned. Finally, relevant PhD dissertations (available from the ProQuest database) were searched. Only studies that used participants' own recognition judgements were included in the meta-analysis—studies that tried to manipulate recognition either directly or indirectly, were excluded. In total, nine studies were found which described the results of 17 experiments or 27 experimental conditions (total $N = 691$) (Anand, Holbrook, & Stephens, 1988; Anand & Sternthal, 1991; Chenier, 2010; Lee, 2001; Matlin, 1971; Obermiller, 1985; Seamon et al., 1983; Wang & Chang, 2004; Wilson, 1979).

The chosen unit of analysis was experimental condition—specifically, each comparison between recognised and non-recognised targets and foils. Experiments or papers were not selected as units of analysis because their aggregation can obscure important differences and because for two papers (Anand & Sternthal, 1991; Obermiller, 1985) it was impossible to correctly aggregate data across conditions.

Meta-analytic technique

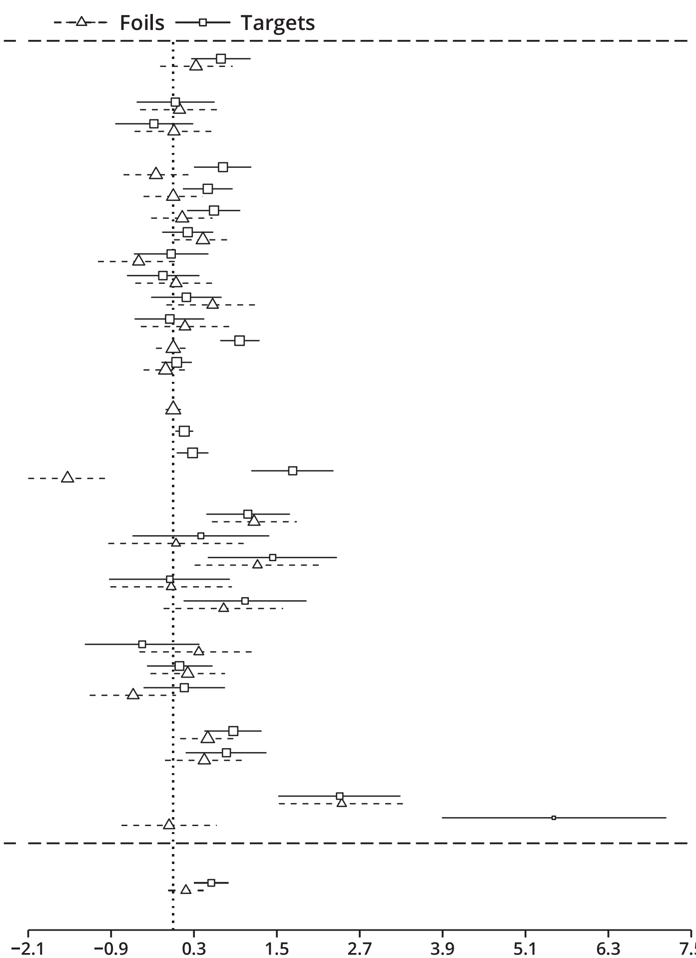
Data were analysed as follows. First, using standard formulas provided in textbooks (Borenstein, Hedges, Higgins, & Rothstein, 2009; Card, 2011) d index (a measure of effect size) for the effect of recognition on preference and its standard deviation were computed both for targets and foils. For the computation of d for Wilson (1979), it was assumed that for preference $SD_{Hits} = 0.9SD_{FA}$ and that $SD_{Misses} = 1.2SD_{CR}$. This assumption is based on the average SD from other studies included in the meta-analysis and above-chance accuracy in this study. Without this assumption it would not have been possible to compute separate SD_d for targets and foils. For Seamon et al. (1983) d_{Cox} was used, which is a good alternatives to d for dichotomous dependent variable data (Sánchez-Meca, Marín-Martínez, & Chacón-Moscoso, 2003).

Next, a random-effect linear regression analysis was conducted using the *metafor* package in R (Viechtbauer, 2010). Recognition served as the independent variable and objective familiarity as a moderator variable.

The results of the analysis are presented in Figure 2. The overall amount of heterogeneity in studies, $\tau^2 = .40$, was significantly above zero, $Q_E(54) = 293.41$, $p < .001$, and the overall effect size of recognition was positive, that is, recognised items were liked more than non-recognised ones, $B = 0.37$, 95% CI [0.19, 0.56], $z = 3.95$, $p < .001$. The addition of the moderator variable (objective familiarity) explained 7% of the total heterogeneity, leaving a significant amount of heterogeneity to be explained by other variables, $\tau^2 = .37$, $Q_E(54) = 264.40$, $p < .001$.

As evident from the plot, most studies yielded small to moderate effect sizes. The total effect of recognition for targets was significantly above zero, $B = 0.55$, 95% CI [0.30, 0.80], $z = 4.29$, $p < .001$. On the contrary, the total effect of recognition for foils was not significantly different from zero $B = 0.18$, 95% CI [−0.07, 0.44],

[3] Dr Lee also generously provided additional data, which was necessary for the proper analysis of the results of the experiments reported in her paper.



Study	Targets *d*	Targets *SE d*	Foils *d*	Foils *SE d*
Matlin (1971)	0.69	0.22	0.33	0.27
Wilson (1979)				
Exp. 1	0.03	0.29	0.09	0.29
Exp. 2	−0.28	0.29	0.01	0.29
Seamon, Brody, Kauff (1983)				
Exp. 1 − nonshadowed	0.72	0.21	−0.25	0.24
Exp. 1 − shadowed	0.50	0.18	0.00	0.22
Exp. 2 − nonshadowed	0.59	0.19	0.13	0.23
Exp. 2 − shadowed	0.21	0.19	0.43	0.21
Exp. 3 − LVF, non−shadowed	−0.03	0.28	−0.50	0.30
Exp. 3 − LVF, shadowed	−0.15	0.27	0.04	0.30
Exp. 3 − RVF, non−shadowed	0.19	0.26	0.57	0.34
Exp. 3 − RVF, shadowed	−0.05	0.26	0.17	0.33
Exp. 4 − LVF	0.96	0.15	0.00	0.13
Exp. 4 − RVF	0.05	0.11	−0.11	0.16
Obermiller (1985)				
0 exposures			0.00	0.06
1−3 exposures	0.16	0.07		
6 exposures	0.28	0.12		
Anand et al. (1988)	1.73	0.30	−1.53	0.29
Anand and Sternthal (1991)				
Exp. 1	1.08	0.31	1.17	0.31
Exp. 2 − left ear	0.40	0.51	0.04	0.50
Exp. 2 − right ear	1.44	0.48	1.22	0.46
Exp. 3 − left ear	−0.05	0.45	−0.03	0.45
Exp. 3 − right ear	1.04	0.45	0.73	0.44
Lee (2001)				
Guess	−0.45	0.42	0.37	0.44
Half sure	0.09	0.24	0.21	0.27
Sure	0.16	0.30	−0.58	0.32
Wang and Chang (2004)				
Exp. 1	0.87	0.21	0.50	0.21
Exp. 2	0.77	0.30	0.45	0.29
Troy (2010)				
Exp. 1	2.41	0.45	2.44	0.47
Exp. 2	5.51	0.83	−0.06	0.35
Summary	0.55	0.13	0.18	0.13

Figure 2. *Results of the meta-analysis of the relationship between objective familiarity, subjective familiarity, and preferences. Note: Values above zero indicate that recognised objects were evaluated more positively than non-recognised objects. Bars indicate 95% confidence intervals. The sizes of data points reflect their relative weight in the meta-analysis. The weights and summary effect sizes were computed using random-effect linear modelling*

z = 1.39, p = .163. The difference in effect size between targets and foils was also significant B = 0.37, 95% CI [0.01, 0.73], z = 2.00, p = .045.

Discussion

The results of the present meta-analysis show that recognition increases liking for targets more than for foils. This finding is consistent with the predictions of the hypotheses testing model. The present findings offer partial support for the uncertainty reduction model, since the effect of recognition is positive both for targets and for foils (albeit the effect is non-significant for the latter). Our meta-analytic findings offer no support for the fluency attribution model, because it predicts that recognised items should be liked less than non-recognised items, and exactly opposite was observed.

The effect of target exposure frequency was evaluated in only one study. Obermiller (1985) reported that for stimuli presented six times the effects of recognition were more powerful than for stimuli presented one, two, or three times. When the stimuli were correctly recognised, six exposures produced higher ratings, while when they were not recognised, the ratings for stimuli with one to three exposures were higher. This pattern is also in favour of the hypotheses testing model, and contrary to the predictions of the fluency attribution account.

In addition to the usual problems associated with meta-analysis, such as heterogeneity of studies, previous studies had some methodological limitations that might have confounded the findings obtained. First, the majority of studies included recognition judgements and preference judgements simultaneously, that is, for each stimulus participants made recognition judgement immediately after or immediately before preference judgement. When participants realise that two judgements have to be made, they can implicitly make recognition judgements before or after preference judgements, without regard to the order suggested by experimenter. Obviously, when recognition judgement happens after preference judgement, the former cannot influence the latter. Thus, on average, the effect of recognition decision on preference could be diminished, as when it happens after preference judgement. The presence of confidence judgements in some of the studies adds a further complication: Participants might resolve the conflict associated with inconsistent prediction by using "guess" or "not sure" ratings of confidence. Finally, the studies included in the present review included a variety of variables that might moderate the effect of recognition on preferences, including lateralised presentation, stimulus type, and focus of attention. While additional research is required to test the role of such moderators, the present findings provide at least preliminary support for the hypotheses testing model.

EXPERIMENT 1

The overall aim of Experiment 1 was to test the predictions of the three models outlined above. According to the fluency attribution model, recognised items will be less liked than non-recognised items. In contrast, the uncertainty reduction model predicts that recognised items will be liked more than non-recognised items. Finally, the hypotheses testing model predicts that there should be an interaction between recognition and objective familiarity on preferences, such that recognised items will be liked more than non-recognised items but that this difference will be greatest at high levels of stimulus exposure.

The experiment was divided into two blocks, with half of the participants receiving the same stimuli for memorising, recognition and preference judgements twice ("repeated blocks" condition). This was done in order to compare liking for stimuli before the second recognition decision with liking for stimuli after the second recognition decision. For the other half of the sample, the stimuli in the second block were novel ("different blocks" condition). This design allows three main types of analysis: Analysis of preferences in the first block, comparison between preferences in the first and the second block in "repeated blocks" condition, and comparison of preferences between conditions in the second block. The predictions for preferences in the first block are already stated above. With regard to the second and third types of analysis both fluency attribution and uncertainty reduction accounts predict that in the "repeated blocks" condition, regardless of the recognition decision, stimuli preference should increase in the second block as a result of greater processing efficiency and less uncertainty (due to increased objective familiarity). Thus, a comparison of preferences between blocks in the "repeated blocks" condition should demonstrate an overall increase in preferences for target items, with more often presented items liked more than less presented ones. Likewise, a comparison between conditions in the second block should demonstrate an interaction between condition and exposure frequency, with more often exposed stimuli preferred more in the "repeated blocks" condition. In both cases, the effect of recognition should be the same as in the first block, and it should not interact with condition or exposure frequency.

Conversely, the hypotheses testing model predicts that as well as in the first block, preferences in the second block depend on a recognition decision. Consequently, when comparing preferences between blocks, there should be an interaction between recognition and exposure frequency. More often presented stimuli should be evaluated more positively, if they are recognised, and more negatively, if they are not recognised. Accordingly, the comparison of preferences between conditions should demonstrate a three-way interaction between condition, recognition and exposure frequency.

The experiment was conducted via the internet using custom JavaScript software. Although internet-based studies are generally considered to be more "noisy" than laboratory studies, this opinion is not supported by several attempts to directly investigate this issue (Keller, Gunasekharan, Mayo, & Corley, 2009; Lewis, Watson, & White, 2009; Reimers & Stewart, 2007). Moreover, the main units of analysis were simple choices or ratings of stimuli, which do not demand much from the hardware equipment. Finally, any potential increase in random noise is compensated for by a large sample size.

Method

Design. The experiment utilised a 2 × 2 × 4 × 2 design with one between-group variable (Condition: "different blocks" vs. "repeated blocks"), and three within-subject variables (Block: 1 vs. 2; Exposure Frequency: 0, 1, 5 or 9 exposures; and Recognition: recognised vs. non-recognised). This design is commonly utilised in studies of mere exposure except that in the present experiment the preference and recognition phases were separated.

Participants. Cases were excluded where: (1) the participant stated that he or she had taken the test before (or when the researcher had suspicions that this might be the case due to the same IP address, browser, operating system, and name–sex–age information), or (2) the participant indicated any type of technical problems (there were two such comments). In addition, three participants were excluded as they had 10% or more recognition answers with latencies below 500 ms, and 13 were excluded as they spent more than 20 minutes completing the experiment. Pilot testing demonstrated that these thresholds were reasonable enough (see also the results section). Given these exclusion criteria, data from 271 participants were included in the analysis. All participants were randomly assigned to one of two conditions. In the "different blocks" condition there were 37 males and 99 females. In the "repeated blocks" condition there were 35 males and 100 females. No incentives were provided for taking part with the exception that participants received feedback about the number of items they correctly remembered.

Materials and procedure. Prior to the experiment, participants completed a registration form in which they indicated their name, age, and gender. They were also asked to indicate whether they had previously participated in the experiment.

[4] Portions of the research in this paper use the FERET database of facial images collected under the FERET program, sponsored by the DOD Counterdrug Technology Development Program Office.

Information about time of participation, IP address, web browser, and operating system was also obtained. The latter data were collected only for excluding cases where participants failed to disclose that they had already participated in the experiment.

Ninety-six coloured photographs (male, Caucasian) from the FERET database (Phillips, Moon, Rizvi, & Rauss, 2000; Phillips, Wechsler, Huang, & Rauss, 1998)[4] were cropped and centred on the face. The background was changed to white; the brightness of photographs was manually adjusted to approximately equal values. For each participant, the images were randomly divided into two equal blocks (48 stimuli per block). Thirty-six of the stimuli in each block were presented for memorising one, five or nine times (12 stimuli per exposure frequency). Each picture was presented for 300 ms, with a 100 ms interval between presentations of the stimuli. Participants were instructed to watch carefully and try to remember as many stimuli as they could. Presentations of the same stimuli were separated by at least two different stimuli. The remaining 12 stimuli served as foils in the recognition and liking phases.

Participants were then given a recognition task. They were instructed to press the "right arrow" key if the stimulus had been seen before and the "left arrow" if it had not been seen before. Participants were encouraged to "decide as quickly as you can, although trying to be accurate". After the recognition task, participants were required to evaluate the same stimuli (in a randomised order) on "liking" and "pleasantness" using a 4-point scale (from *Unpleasant, don't like* to *Pleasant, like*). Finally, this procedure was repeated using the second (novel) block of stimuli for participants in the "different blocks" condition, and was repeated using the same stimuli (in random order) for participants in the "repeated blocks" condition. After the experiment, participants were asked to comment on what they liked and did not like about the experiment, whether they had experienced any technical or other problems, and anything else they wished to comment on. No participants in the "repeated blocks" condition indicated that they were aware that the stimuli in the second block were the same as those used in the first block.

Results

The mean number of recognition answers with latencies below 500 ms was 0.49, SD = 1.20. On average, participants spent 11.2 minutes completing the experiment, SD = 2.0. This shows that the excluded participants can be regarded as outliers, as their parameters were outside the mean plus three standard deviations border.

Recognition. Data with recognition or liking latency times above the 98th percentile or below the second percentile were excluded from subsequent analyses. This cut-off was set in order to remove the cases where subjects were distracted by external factors or were answering randomly. Second and 98th percentile is almost the same as ± 2 sigma without bearing the assumption of Gaussian distribution. With the inclusion of these outliers, the significance levels reported further are the same, although confidence intervals are expectedly wider.

To test for an influence of frequency on recognition, a logistic regression analysis was conducted in which recognition was the dependent variable and frequency, condition, and block were the independent variables. There was no significant difference between the conditions on recognition accuracy in the first block, although the beta value was approaching significance (B = 0.08, SE = 0.04, p = .058). The recognition rates were positively associated with frequency of exposure (B = 0.28, SE = 0.00, $p < .001$). Foils were recognised in 35–45% of cases, while items presented nine times were recognised in 79–91% of cases, see Table 1. There were also significant effects of block, B = −0.25, SE = 0.04, $p < .001$, and the anticipated Block × Condition interaction, B = 0.50, SE = 0.06, $p < .001$, see Table 2 for the full regression model. These results show that in the "different blocks" condition the overall probability of recognition decreased from Block 1 to Block 2 (64% vs. 58% recognised), however, in the

Table 1. *Recognition rates in Experiment 1*

	Block 1			*Block 2*		
	RR	*d'*	β	*RR*	*d'*	β
Diff. blocks						
0 exp.	.35			.36		
1 exp.	.49	0.37	1.08	.46	0.24	1.06
5 exp.	.79	1.18	0.79	.72	0.93	0.90
9 exp.	.91	1.71	0.45	.79	1.16	0.76
Rep. blocks						
0 exp.	.36			.45		
1 exp.	.52	0.39	1.06	.60	0.37	0.98
5 exp.	.81	1.25	0.72	.83	1.08	0.64
9 exp.	.90	1.64	0.47	.90	1.44	0.43

Notes: N = 271; No. obs. = 23,976. 0–9 exp. = number of exposures; *RR* = recognition rate, share of items judged to be seen before, equal to false alarms in the case of foils and hits in the case of targets; d' = measure of discriminability; β = measure of bias.

"repeated blocks" condition the reverse effect was observed (65% vs. 70%).

Since participants in the "repeated blocks" condition saw all stimuli in the recognition and liking tasks twice, the overall increase in recognition is not surprising. The decrease in recognition rates in the "different blocks" condition might be explained by tiredness or increased interference from the first block.

Preferences: Block 1. To analyse the nature of the relationship between recognition and liking a linear mixed effect regression (LMER) was conducted using Block 1 preference ratings as the outcome variable and recognition, exposure frequency, condition and their interactions as predictor variables. Stimuli, especially faces, differ in their attractiveness, and people may have different base levels and use different strategies for attractiveness ratings. Unlike analysis of variance (ANOVA) with by-subject aggregation (the more traditional alternative data analytic technique here) LMER takes this variation into account by including random effects for participants and items in the model (see Baayen, Davidson, & Bates, 2008). ANOVA requires additional techniques such as parallel by-stimulus analysis and *minF'* computation (Raaijmakers, Schrijnemakers, & Gremmen, 1999), and these techniques are inferior to the explicit control of random variation implemented in linear mixed models (Judd, Westfall, & Kenny, 2012). Moreover, repeated-measures ANOVA requires a complete, balanced array of data, but the data obtained here were both unbalanced (participants made different numbers of errors) and incomplete (data from some participants were not available for some combinations of Frequency × Recognition). Given these considerations, LMER was chosen instead of ANOVA with by-subject aggregation.

Table 2. *Logistic regression on recognition in Block 1 of Experiment 1*

	B	*SE*	*Z*	*p*
Intercept	−0.36	0.03	−11.24	< .001
Frequency	0.28	0.00	57.72	< .001
Block (2 vs. 1)	−0.25	0.04	−6.12	< .001
Cond. (rep. vs. diff.)	0.08	0.04	1.89	.058
Block × Condition	0.50	0.06	8.43	< .001

Notes: N = 271; No. obs. = 23,976.

LMER analysis indicated that condition and its interaction with recognition and frequency were not significant; thus, condition was excluded from the model. In the final model, results were in line with predictions of the hypothesis testing model: there was a significant effect of recognition, B = 0.07, 95% CI [0.01, 0.13], p = .027, which was qualified by its interaction with frequency, B = 0.02, 95% CI [0.00, 0.03], p = .020. There was no main effect of frequency, B = 0.00, 95% CI [−0.01, 0.01], p = .961. The nature of the interaction between recognition and frequency was investigated via conducting two separate regression analyses: one for recognised items and one for non-recognised items, treating frequency as a categorical variable and foils serving as a baseline for comparison ("treatment" contrasts). The obtained adjusted means and their confidence intervals are shown in Figure 3. This analysis showed that recognised items presented 5 or 9 times were evaluated more positively than recognised foils (i.e., false alarms), see Table 3. There was no significant effect of frequency for non-recognised items.

Finally, separate comparisons of liking ratings for recognised items and non-recognised items at different levels of exposure frequency showed that

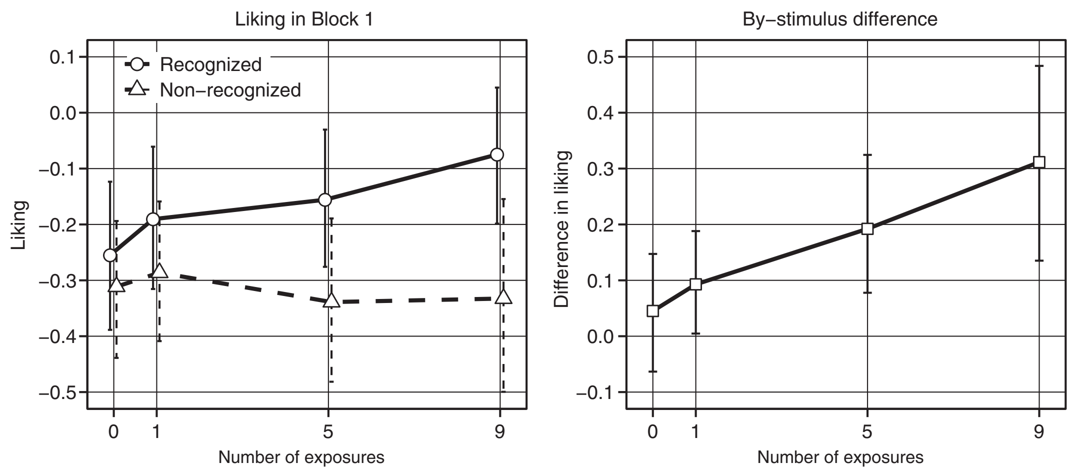


Figure 3. *Adjusted means for liking (left) and difference in liking between recognised and non-recognised stimuli with by-stimulus analysis (right) in Experiment 1. Notes: Bars indicate 95% confidence intervals. (Non-)recognised items = items correctly or incorrectly judged to be (not) presented earlier.*

the effect of recognition was significant only for items presented five times, B = 0.16, 95% CI [0.05, 0.26], p = .003, and for items presented nine times, B = 0.19, 95% CI [0.06, 0.35], p = .010. There was no effect of recognition on preferences for foils, B = 0.07, 95% CI [−0.03, 0.16], p = .165, and for items presented once the effect was only approaching significance, B = 0.08, 95% CI [−0.00, 0.17], p = .067.

In addition, to show that the obtained effect cannot be explained by the selection of stimuli that differ in attractiveness, a by-stimuli analysis of preferences was conducted. For each stimulus, the difference in preference ratings between the cases when it was recognised and non-recognised was calculated. This analysis was conducted for each level of exposure frequency. In contrast to by-subject aggregation, there were zero empty cells so an

Table 3. *Means and regression coefficients for liking in Block 1 and Block 2 of Experiment 1*

	Block 1				*Block 2*			
	Familiar		Unfamiliar		Familiar		Unfamiliar	
	Mean	*B*	*Mean*	*B*	*Mean*	*B*	*Mean*	*B*
0 exp.	−0.25		−0.31		−0.22		−0.33	
	(0.07)		(0.06)		(0.07)		(0.06)	
1 exp.	−0.19	0.06	−0.29	0.02	−0.16	0.06	−0.32	0.01
	(0.06)	(0.05)	(0.06)	(0.04)	(0.06)	(0.04)	(0.06)	(0.04)
5 exp.	−0.16	0.10*	−0.34	−0.03	−0.12	0.10*	−0.40	−0.07
	(0.06)	(0.04)	(0.07)	(0.05)	(0.06)	(0.04)	(0.07)	(0.05)
9 exp.	−0.07	0.18***	−0.33	−0.02	−0.07	0.15***	−0.25	0.08†
	(0.06)	(0.04)	(0.09)	(0.07)	(0.06)	(0.04)	(0.07)	(0.06)
Cond.						0.11†		−0.13*
						(0.06)		(0.06)
No. obs.	7,678		4,305		7,667		4,326	

Notes: N = 271. Values in parentheses denote standard deviations of means and standard errors of regression coefficients (B). For different exposure frequencies regression coefficients are provided for comparison with base level (zero exposures). ***p < .001; **p < .01; *p < .05; †p < .10.

analysis of preference difference with ANOVA was possible. A one-way ANOVA showed a significant effect of Exposure Frequency, $F(3, 366) = 3.18$, $p = .024$. As shown in Figure 3, for foils recognition decision had no influence on preferences. However, target stimuli were evaluated more positively when they were presented and recognised compared to when they were presented but not recognised. This difference monotonically increased from one to nine exposures. As in this analysis initial attractiveness of stimuli is fully controlled, it cannot be used to explain the observed findings.

Preferences: Block 2. The analysis of preferences in Block 2 was analogous to that conducted for the Block 1 preferences (see Table 3 for means ratings). All main effects were non-significant. However, there was a significant two-way interaction between recognition and condition, $B = 0.14$, 95% CI [0.02, 0.26], $p = .017$; a marginally significant two-way interaction between frequency and condition, $B = -0.02$, 95% CI [−0.05, −0.00], $p = .060$; and a significant three-way interaction between frequency, condition and recognition, $B = 0.03$, 95% CI [0.00, 0.06], $p = .034$. As liking of recognised items and liking of non-recognised items were expected to differ between conditions, separate linear mixed models were created for liking of recognised stimuli and liking of non-recognised stimuli in Block 2 using frequency and condition and their interaction term as predictors. The interaction was not significant in either model, $p > .1$; thus, the models were rebuilt to include only main effects.

For recognised items a significant effect of frequency was found: Items presented five times, $B = 0.10$, 95% CI [0.02, 0.17], $p = .013$, and those presented nine times, $B = 0.15$, 95% CI [0.08, 0.23], $p < .001$, were rated more positively than foils. The effect of condition was approaching significance: recognised stimuli in the "repeated blocks" condition were liked more than recognised stimuli in the "different blocks" condition, $B = 0.11$, 95% CI [−0.00, 0.23], $p = .087$. For non-recognised items there was only a significant effect of condition: Non-recognised stimuli were liked less in the "repeated blocks" condition than in the "different blocks" condition, $B = -0.13$, 95% CI [−0.24, −0.02], $p = .034$. The between-group differences for liking of recognised versus non-recognised items are presented in Figure 4.

Differences between liking of stimuli in the first versus second blocks in the "repeated blocks" condition were then analysed using LMER without the intercept term. This is analogous to a two-way comparison of difference with zero or a paired Student's t-test. As shown in Table 4 and Figure 4, the difference between Blocks 1 and 2 on liking for non-recognised targets was significantly negative, $t = -2.01$, $p = .044$, targets that were not recognised in the second block were evaluated more negatively after the recognition decision than before it. In contrast, recognised targets were evaluated more positively, $t = 2.98$, $p = .003$. A similar analysis conducted on the foils yielded no significant results, indicating that either the effect of recognition decision for foils was too small, or that recognition decision has effects only in the presence of new information.[5]

[5] Could it be that the obtained differences are due to the amplification of recognition decision? The decisional amplification suggests that repeating the same decision is self-supporting, that is, the decision becomes faster and more confident. It is possible that there is an amplification of preferences with repeated evaluation: positive items become more positive and negative items become more negative. As recognition correlates with preferences this effect can be used to explain the observed pattern of preferences for targets in Block 2. Still, it does not explain why amplification is observed only for targets. The inclusion of random stimuli effects in LMER also decreases such a possibility. Nevertheless, an analysis of liking differences equivalent to the one described above was conducted, using liking valence (positive vs. negative) in Block 1 as a predictor. The results were quite clear: Preferences increased for initially negative stimuli, $B = 0.50$, $SE = 0.03$, $t = 14.96$, $p < .001$, and decreased for initially positive stimuli, $B = -0.53$, $SE = 0.04$, $t = -15.00$, $p < .001$. This finding corresponds to a regression to the mean effect and not to exaggerated ratings. Consequently, the amplification of preferences cannot explain the previously described results.

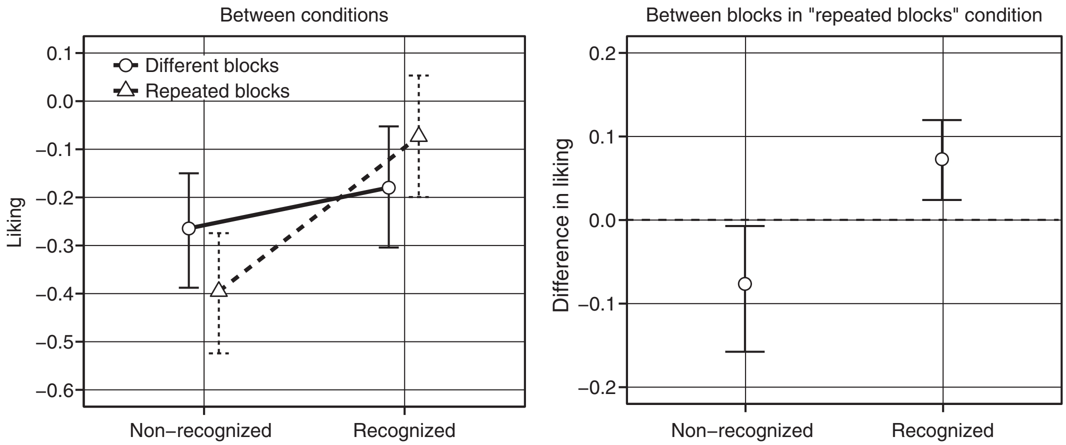


Figure 4. *Adjusted means and their confidence intervals for liking in Block 2 of Experiment 1. Notes: Bars indicate 95% confidence intervals. In repeated blocks condition participants remembered, recognised, and made preference judgements for identical stimuli in Block 1 and Block 2. In different blocks condition stimuli in Block 1 and Block 2 were different. Difference in liking is the difference between liking of item in Block 2 and Block 1. "Recognised" and "Non-recognised" = recognition decision in Block 2.*

Discussion

The findings from this experiment provide support for the hypothesis testing model. There was a significant two-way interaction between recognition and objective familiarity in the analysis of preferences in the first block. The difference in liking of recognised versus non-recognised items was positively associated with exposure frequency.

Table 4. *Linear mixed regression model for differences in liking between Block 2 and Block 1 of Experiment 1 ("repeated blocks" condition)*

	B	*SE*	*t*	*p*
Targets, No. obs. = 4,173				
Non-recognised items vs. 0	−0.08	0.04	−2.01	.044
Recognised items vs. 0	0.07	0.02	2.98	.003
Foils, No. obs. = 1,361				
Non-recognised items vs. 0	−0.02	0.04	−0.39	.700
Recognised items vs. 0	0.00	0.04	0.09	.931

Notes: Model is fitted without Intercept to provide a two-way comparison of difference in liking with zero. Significant deviation from zero in this model means that liking decreased (if regression coefficient is negative) or increased (if regression coefficient is positive) from Block 1 to Block 2.

Recognition had no significant effect on preferences for foils and targets presented one time. However, its effect was significantly above zero for targets presented five or nine times. The obtained findings are against the predictions of fluency attribution model, as no evidence of decreased preferences for recognised items was found. They are partially consistent with predictions of the uncertainty reduction model as there was a positive effect of recognition. However, this model cannot explain why this positive effect was evident only for items present for five or nine times.

In the second block, important differences were found between liking ratings in the "repeated blocks" condition—in which participants received the same stimuli set for remembering, recognition, and liking—and the "different blocks" condition, in which participants received a novel set of stimuli: Non-recognised stimuli were liked less and recognised stimuli were liked more in the "repeated blocks" condition. Likewise, comparison of the preferences in the first block and the second block in the "repeated blocks" condition revealed that liking ratings increased for recognised targets and decreased for non-recognised targets. That is, after second presentation of the same stimuli, participants evaluated these stimuli more negatively if they failed to recognise them and more positively if they managed to do it. This pattern of results is again in support of the hypothesis testing model, as only this model predicts a three-way interaction between condition, recognition, and objective familiarity. It is inconsistent with the predictions of the uncertainty reduction and fluency attribution models, as they predict that both recognised and non-recognised targets should be evaluated more positively in the second block due to increased fluency of processing or reduced uncertainty.

The observed interactions also make evident that the mere exposure effect itself is actually dependent on recognition, at least in the present study. Only for recognised items are preferences positively associated with exposure frequency. On the contrary, frequency of exposure had no effect on preferences for non-recognised items in the first block. Moreover, repeated exposure of the same stimuli in "repeated blocks" condition even led to a decrease in preference for non-recognised targets.

The findings from this experiment corroborate the results of the conducted meta-analysis and provide further support for the hypotheses testing model. However, some of them can be explained by selection on the basis of preferences. If participants recognised more pleasant items more often, then with more exposures only less pleasant items will remain non-recognised. Yet, the results of by-stimulus analysis and of repeated liking comparisons in the second block are hard to explain on this basis. If participants evaluate the same items, why would the liking ratings change after the second recognition, especially given that the direction of changes is opposite for recognised and non-recognised items? Similarly, why would the difference between the preferences for the very same items when they are recognised and when they are not recognised increase with increasing numbers of exposures? Given the absence of simple answers to these questions, an explanation in terms of selection seems implausible.

In order to provide a further test for the hypotheses testing model, a second experiment was conducted that aimed to reduce the effect of the pre-decisional stage on preferences and to examine the causal role of recognition on preferences by varying task order.

EXPERIMENT 2

In order to provide a clearer demonstration of the influence of recognition decision upon preference ratings, that is, the influence of the post-decisional stage, other sources of influence must be weakened. Specifically, it is important to reduce the influence of the pre-decisional stage, because like the post-decisional stage its influence depends on objective familiarity. Thus, in case of erroneous non-recognition the preference ratings for often exposed stimuli, on the one hand, will be positively influenced by familiarity due to pre-decisional stage, and, on the other hand, will be negatively influenced by the post-decisional stage. Those influences can compensate each other. Consequently, the overall preference ratings will be neutral, as happened for non-recognised items in Experiment 1. Thus, a manipulation that attenuates the effect of the pre-decisional stage is needed. In other words, the attenuation of the mere exposure effect is required. This is not an easy task as the mere exposure effect is a robust phenomenon and upholds under a variety of conditions—even the most subtle of manipulations produces the effect (Kunst-Wilson & Zajonc, 1980).

However, in the majority of the existing mere exposure studies, stimuli have been presented at intervals; yet, there is evidence to suggest that when stimuli are presented without post-stimulus intervals, memory for those stimuli is significantly worse, even when the stimuli are easily remembered when presented alone for the same duration (e.g., Subramaniam, Biederman, & Madigan, 2000). Thus, this manipulation should diminish the mere exposure effect, leaving the influence of the recognition decision intact. So far as the author is aware, this technique has been implemented in only two studies to date, Whittlesea and Price (2001) and Newell and Shanks (2007), both of which involved a 40 ms exposure time. Although Whittlesea and Price (2001) demonstrated enhanced positive evaluation of items in the absence of recognition, providing support for the robustness of the mere exposure effect, Newell and Shanks (2007) demonstrated above chance recognition in the absence of the mere exposure effect. That is, in the latter study the effects obtained by Whittlesea and Price (2001) were not replicated. Thus, the question of the existence of the mere exposure effect with short presentations and no post-stimulus interval is still open.

In light of the above evidence and the difficulty of perceiving items presented under such conditions, in this experiment I expected a reduced mere exposure effect in the presence of changes in objects liking due to the recognition decisions made. Consequently, the decrease in preferences for non-recognised items with increasing frequency of exposure should become significant. That is, there should be an influence of recognition decision upon preference ratings even when the mere exposure effect is attenuated.

The second goal of this experiment was to examine the causal relationship between recognition decisions and preference judgements. Specifically, the experiment examined whether recognition decisions cause changes in preference ratings, and whether preference ratings cause changes in recognition decisions. If the predictions of the proposed account of preferences are correct, then the effect of recognition decision on preferences will be different from the effect of preference judgements on recognition. The hypothesis testing model predicts that the effect of recognition on preferences will be moderated by exposure frequency. In contrast, the strength of the effect of preference ratings on recognition will not be dependent upon exposure frequency.

The present experiment also used different face stimuli to control for the potential confound of stimulus-specific influence.

Method

Design. The experiment utilised a 2 × 2 × 2 design with Task Order ("recognition first" vs. "preferences first") as the between-group variable and Exposure Frequency (1 vs. 5 exposures) and Recognition (recognised vs. non-recognised) as within-subject variables.

Participants. The exclusion criteria were the same as those in Experiment 1, with the exception that data were excluded when participant spent longer than 15 minutes completing the experiment. Five participants exceeded this time limit. A further 15 were excluded as a result of giving more than 10% of their answers with latencies below 500 ms. In total, 135 participants (35 males; 100 females; Mdn_{age} = 22.5 years) voluntarily participated. As in Experiment 1, no incentives were provided for taking part with the exception that participants received feedback about the number of correctly remembered items.

Materials and procedure. Experimental stimuli were 88 photographs of faces (60 male; 28 female) from The Psychological Image Collection at Stirling (PICS; The Psychological Image Collection at Stirling, n.d.). The experiment consisted of a training phase, in which the stimuli were presented, and two test phases. In the training phase, 44 randomly chosen stimuli were presented; half of these were presented only once and the other half were presented five times. This resulted in a stream of 132 pictures. Exposures of the same stimuli were separated from each other by at least two different stimuli. Pictures were presented for 40 ms without a post-stimulus interval. Participants were instructed to watch carefully and to try to remember as many stimuli as they could. On both test phases participants completed a forced-choice task: They were instructed to select either the item they most preferred or the item they thought was presented in the training phase from one old and one new item. Task order was balanced between participants: Participants either first completed the preference task ("preferences first") or the recognition task ("recognition first"). The number of male and female photographs was counterbalanced across target and foil stimuli. The two stimulus items were presented side by side; the position of target stimuli was counterbalanced. Participants were requested to press the "left arrow" key or "right arrow" key to select a stimulus. Decision time was unlimited. Stimulus pairs in both tasks were chosen randomly from presented and non-presented stimuli.

Results

The mean number of answers with less than a 500 ms latency was 0.3 (0.2% of all answers), *SD* = 0.8. Mean time needed to complete the experiment was 7.8 minutes, *SD* = 1.0. For each task in each test phase, answers with latency times longer than the 98th percentile or shorter than the second percentile were excluded as possible outliers.

First, one-sided exact binomial tests were conducted to analyse whether the probability of choosing items presented once or five times was higher than 0.5. This analysis was carried out separately for each group. In all cases no significant differences were found. The corresponding chances that the target stimuli would be chosen by participants for items presented once and five times were 51% and 53% in the recognition task and 51% and 50% in the preference task.

The choice of target stimuli in the second task was then analysed using logistic regression. It is important to note that although the targets and foils that were presented in both tasks were identical, the influence of their recognition (or liking) in the first task on choices in the second task can be measured separately as *pairs* were different in each task. Thus, for example, in preference task possible combinations were a recognised foil and a recognised target, a recognised foil with a non-recognised target, a non-recognised foil with a recognised target, and a non-recognised foil with a non-recognised target. Accordingly, the independent variables were the choices made in the first task about the target and foil items (i.e., whether target and foil were selected in preceding recognition decision or preference judgement), the target item's exposure frequency, and the interaction between frequency and previous choice. This enables the relative influence of foils versus targets to be compared—for example, whether the choice of target in the first task has a greater influence than the choice of foil on the target chosen in the second task.

The resulting models for preference with and without the Frequency × Target Recognition interaction term are presented in Table 5. First, it should be noted that the main effect of Target

Table 5. *Logistic regression models for preference after recognition and recognition after preference in Experiments 2 and 3*

	Experiment 2				*Experiment 3*			
	Preference		*Recognition*		*Preference*		*Recognition*	
Intercept	−0.13	−0.03	0.01	0.01	−0.08	−0.01	−0.05	−0.03
	(0.08)	(0.09)	(0.08)	(0.09)	(0.05)	(0.06)	(0.05)	(0.06)
FC	−0.30***	−0.31***	−0.34***	−0.34***	−0.24***	−0.24***	−0.24***	−0.24***
	(0.08)	(0.08)	(0.08)	(0.08)	(0.05)	(0.05)	(0.05)	(0.05)
TC	0.47***	0.28*	0.43***	0.42***	0.39***	0.25***	0.26***	0.23**
	(0.08)	(0.11)	(0.08)	(0.11)	(0.05)	(0.08)	(0.05)	(0.08)
EF	−0.07	−0.28*	0.01	0.01	0.02	−0.13†	0.14*	0.10
	(0.08)	(0.11)	(0.08)	(0.11)	(0.05)	(0.08)	(0.05)	(0.08)
TC × EF		0.40**		0.00		0.29**		0.07
		(0.15)		(0.15)		(0.11)		(0.11)
No. obs.	2,777		2,721		5,637		5,542	
N	68		67		102		100	

Notes: Numbers represent regression coefficients (and standard errors). Dependent variable = whether target item has been chosen in the second task. FC = foil has been chosen in the first task (as previously seen or more preferred, depending on the first task); TC = target has been chosen in the first task; EF = number of target exposures, five versus one. Pairs of columns for each task represent regression models with and without interaction effect, respectively. ***$p < .001$; **$p < .01$; *$p < .05$; †$p < .10$.

Recognition (without the interaction term in the model) was larger in absolute value than the effect of Foil Recognition. Recognised targets were preferred in 54% of cases, while non-recognised targets were preferred in only 42% of cases. For foils, the corresponding probabilities were 56% and 48%. Two regression analyses (one for items presented only once, and one for items presented five times) were conducted in order to examine whether this difference was statistically significant and, if so, at which levels of exposure frequency.

Subsequent comparisons of estimated coefficients confirmed that for items presented five times the effect of recognition for target items, $B = 0.68$, $SE = 0.11$; is indeed larger in absolute value than the effect of recognition for foils, $B = -0.38$, $SE = 0.11$, Wald's $\chi^2(1) = 3.86$, $p = .049$. The corresponding probabilities of choice for recognised and non-recognised target items were 56% and 39% and for recognised and non-recognised foils 57% and 48%. For items presented once this difference was not significant, and the corresponding probabilities were 53% and 45% for target items and 54% and 48% for foils.

Second, as evident from the second column of Table 5 there was a significant interaction between Exposure Frequency and Target Recognition indicating that the effect of recognition was higher for items presented five times than for items presented once. Significant negative exposure frequency effect shows that for non-recognised items the probability of choosing an item presented five times was significantly lower than the probability of choosing an item presented once. A chi-square test conducted for recognised items did not show a significant effect of exposure frequency on preference for target item, $\chi^2(1) = 1.18$, $p = .277$ (see Figure 5).

In contrast, an identical regression model for the effects of frequency, preference for target, and preference for foil on recognition in the second task demonstrated no difference in the magnitude of regression coefficients for preference for target and preference for foil (see Table 5, third and fourth columns). The corresponding probabilities of recognition were 53% and 44% for preferred and non-preferred foils and 57% and 54% for preferred and non-preferred targets, regardless of exposure frequency. As can be seen from the regression coefficients and recognition probabilities, preferred stimuli were recognised more often. However, the magnitude of difference did not depend upon the number of previous exposures. Consequently, and again in contrast to the model of recognition effect on liking, the interaction effect between preference for target and exposure frequency was not significant. The observed pattern of findings for the effect of preference on recognition shows evidence for biased recognition, but no evidence for any exposure-related differences.

Finally, as in Experiment 1, a by-stimulus analysis of differences in liking was conducted. For each stimulus, the probability of the stimulus being preferred as a function of preceding recognition and exposure frequency was calculated. As the pairs of targets and foils for both tasks had been selected at random, both targets and foils were included. A one-way ANOVA showed no effect of Exposure Frequency, $F(2, 260) = 1.86$, $p = .158$. However, as is evident from Figure 6, the difference between recognised and non-recognised items on liking was significantly above zero for target stimuli that were presented five times, $t(86.0) = 3.37$, $p = .001$, but not for items presented only once, $t(87.0) = 1.39$, $p = .168$, or foils, $t(87.0) = 1.71$, $p = .09$. The difference in liking between target items presented five times and foils was approaching significance, $t(154.0) = -1.79$, $p = .076$.

Discussion

The main finding from Experiment 2 is consistent with the hypotheses testing model: All things being equal, in preference tasks for recognised items the probability of choosing an item presented five times is higher than the probabilities both of choosing an item presented only once and choosing a foil. For non-recognised items, the opposite is true: items presented five times are less likely to be selected in the preference task than items presented once or foils. That is, there is an interaction effect of recognition and objective

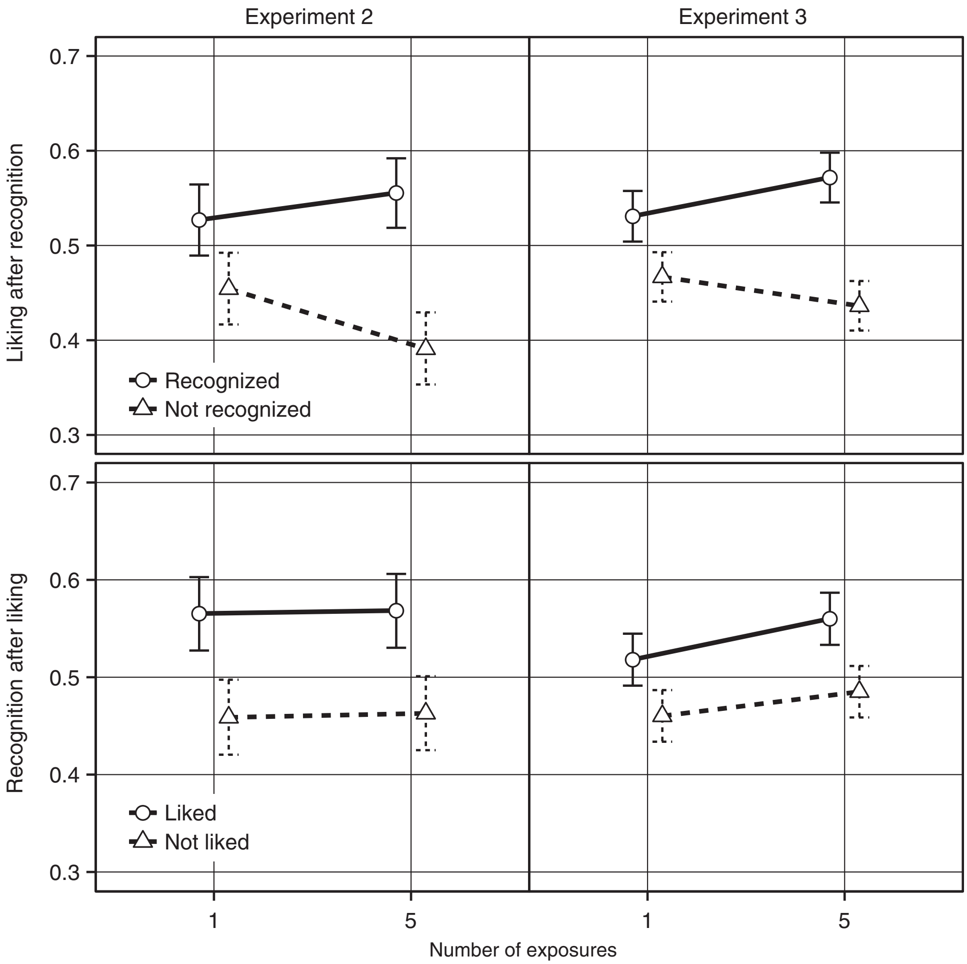


Figure 5. Liking after recognition and recognition after liking as function of number of exposures in Experiments 2 and 3. Notes: Liking and recognition are the probabilities of choosing the target in the corresponding 2AFC task. Bars indicate 95% confidence intervals.

familiarity on preference. As well as in the previous experiment the predictions of uncertainty reduction were partially supported by a positive effect of recognition on preferences, and the predictions of the fluency attribution model found no support in the obtained results.

Findings from the present experiment also demonstrate a causal effect of recognition on preferences: The interaction between exposure frequency and choice in the first task was evident only when recognition preceded liking, and not the other way around. Similarly, no significant difference was found between foils and targets in the magnitude of the effect of preferences on recognition. The main effect of preference on recognition indicates the presence of an affective bias in recognition: that is, recognition decision is more likely to result in “Recognise” answer for more attractive faces. This bias is explained by the hypotheses testing model, as it suggests that the affective feedback for hypothesis testing on decisional stage can be confused with affect from other sources. Thus, attractiveness of faces can be misinterpreted as a positive feedback for the

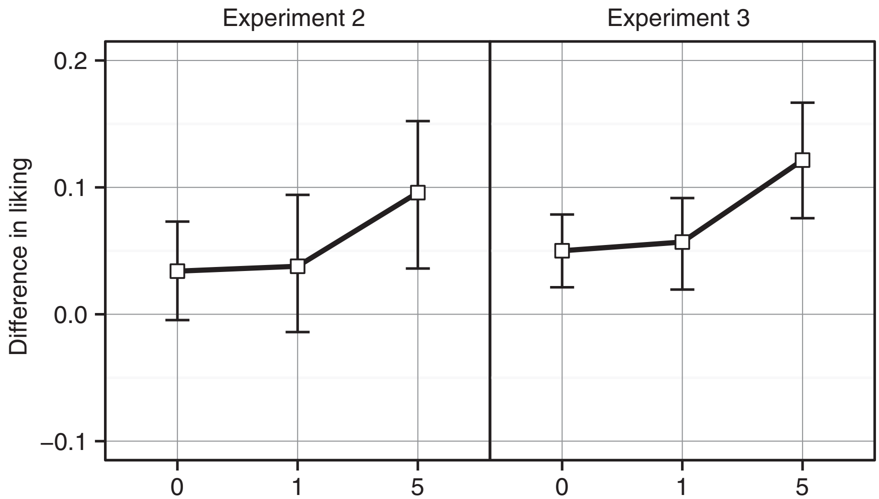


Figure 6. Difference in liking between recognised and non-recognised stimuli with by-stimulus analysis in Experiments 2 and 3.

recognition hypothesis. However, this finding runs counter to the fluency attribution model, which predicts that attributing fluency to liking should decrease (rather than increase) the likelihood that items will be recognised. The uncertainty reduction account does not make predictions in relation to the effect of liking on recognition.

In sum, findings from the present experiment support those of Experiment 1 and clearly show that the preference of recognised items and the recognition of preferred items are not equal to each other.

As expected, Experiment 2 also demonstrated an effect of decision making on subsequent preferences in the absence of the mere exposure effect. An increase in preferences for recognised items was associated with a corresponding decrease in preferences for non-recognised items. As the distribution of recognised versus non-recognised items was roughly equal here, average liking did not differ from base level. However, given the fact that previous studies have demonstrated the mere exposure effect in the absence of recognition (e.g., Zajonc, 1980), the mechanisms underpinning such an effect are unclear. Since the present experiment showed differences in preferences for items with different exposure frequencies, it is not the absence of implicit memory that leads to the absence of the mere exposure effect.

One possible explanation can be offered from the perspective of the distinction between analytic and non-analytic processing, suggested by Whittlesea and Price (2001). Analytic processing is based on the retrieval of specific details of an item or its context and is mostly used in recognition tasks. Non-analytic processing, on the other hand, is based upon the feeling of enhanced fluency and is utilised in preference tasks or familiarity judgements. Thus, in the current experiment, it is possible that the “remember as much as you can” instruction induced an analytic strategy even in the preference task. Experiment 3 aimed to address this issue and replicate the findings from Experiment 2.

EXPERIMENT 3

Experiment 3 was a replication of Experiment 2 with two differences: First, since portraits of humans can bear some distinctive marks and thus promote the analytic processing mode, stimuli in the present experiment consisted of randomly selected ideograms; second, two instructions were used, one of which was equivalent to the instruction provided in Experiment 2, and the other aimed at reducing the possibility that participants would be aware that they would be participating in a memory test.

Method

Design. Experiment 3 employed the same design as Experiment 2, with the exception that an additional between-group variable, Condition, was added. Thus, the experiment utilised a 2 × 2 × 2 × 2 design with Task Order (recognition first vs. preferences first) and Condition ("expected recognition" vs. "surprise recognition") as the between-group variables and Exposure Frequency (1 vs. 5 exposures) and Recognition (recognised vs. non-recognised) as within-subject variables.

Participants. The exclusion criteria were the same as those employed in Experiment 2. Participants (N = 202) were randomly allocated to one of two conditions. In the "expected recognition" test condition there were 29 males and 70 females, Mdn_{age} = 21 years. In the "surprise recognition" condition there were 19 males and 84 females, Mdn_{age} = 23 years.

Materials and procedure. A set of 120 ideograms were randomly selected from the symbols available in the CJK Unified Ideographs set (Unicode Inc. 2011). All ideograms were black. Prior to commencement of the experiment, participants indicated whether they knew or had studied Japanese, Chinese, or any similar language. The presentation and testing phases followed the same procedure as those in Experiment 2 with the exception that participants were randomly allocated to one of two conditions: in one condition ("expected recognition") participants were asked to "watch carefully and try to remember as much as you can"; participants in the other condition ("surprise recognition") were asked to "count the number of times a red square appears on screen". The red square appeared only once after the presentation of all stimuli. After that they were asked how many times the red square appeared and then the recognition test phase began. As participants were not expecting recognition test in the latter condition, and as looking for a red square among ideograms does not suggest attention to ideographs details, it was expected that in this condition participants would be more likely to adopt an holistic processing strategy.

Results

The mean number of answers with latencies below 500 ms was 1.1 (0.9%), SD = 2.1. Mean time taken to complete the experiment was 9.7 minutes, SD = 1.5.

The data analytic technique replicated that used in Experiment 2. Answers with latency times longer than the 98th percentile or faster than the second percentile were excluded as possible outliers. The probabilities of choosing targets presented once and five times were 49% and 50%, respectively, in the recognition task and 50% and 49%, respectively, in the preference task. No significant deviations from chance level were found. Sixteen participants indicated that they had studied Japanese, Chinese, Vietnamese or a similar language, although a separate analysis of these participants' results also indicated no difference from chance level in recognition or preference; thus, they were included in subsequent analyses.

A logistic regression analysis for the preference and recognition tasks was conducted. Predictor variables were choices with regard to targets and foils in the first task (recognised vs. non-recognised; preferred vs. non-preferred) exposure frequency of the target (1 vs. 5 exposures), and condition (expected vs. surprise recognition test). Choice of target in the second task was the dependent variable. No significant effects of condition or its interactions were found; thus, condition was excluded from the subsequent analysis.

The resulting models for preference and recognition with and without the interaction term are presented in Table 5.

As in Experiment 2, in the preference task the main effect of target recognition (without the interaction term) was stronger than the effect of foil recognition. Recognised and non-recognised targets were preferred in 55% and 45% of cases, respectively. The corresponding probabilities for recognised and non-recognised foils were 53% and 47%, respectively.

Separate logistic regressions for items presented once versus five times and comparisons of the estimated coefficients for targets versus foils confirmed that the effect of target recognition, B = 0.54, SE = 0.08, was stronger than the effect of foil recognition, B = −0.25, SE = 0.08, Wald's $\chi^2(1) = 6.92$, $p = .009$. The corresponding probabilities of choice for recognised versus non-recognised target items were 57% and 44%, respectively; the corresponding probabilities of choice for recognised versus non-recognised foils were 53% and 46%, respectively. This difference was not significant for items presented only once. The corresponding probabilities were 53% and 47% for targets and 53% and 47% for foils.

Consequently, as in Experiment 2, when the interaction term (Exposure Frequency × Target Recognition) was added to the model, it was significant. The findings from Experiment 3 differed from those obtained in Experiment 2 only in so far as the effect of exposure frequency was only marginally significant (see Table 5), thus indicating a marginally significant decrease in preferences for non-recognised items. For recognised items, the higher exposure frequency led to a increased probability of preference, $\chi^2(1) = 4.53$, $p = .033$ (see Figure 5).

Replicating the results of Experiment 2, a regression model for the effects of frequency, preference for target, and preference for foil on recognition in the second task exhibited no differences in the magnitude of regression coefficients between preference for target and preference for foils (see Table 5). The corresponding probabilities of choice for preferred versus non-preferred foils, targets presented once, and targets presented five times were 53% and 46%, 52% and 54%, and 56% and 51%, respectively. As in Experiment 2, preferred stimuli were recognised more often but the magnitude of difference did not depend upon frequency of exposure. Again, the observed pattern of findings for the effect of preference on recognition provides evidence of biased recognition, but not evidence of any exposure-related differences. The main difference between the findings in this experiment and those obtained in Experiment 2 is that the main effect of Exposure Frequency was significant, that is, targets presented five times were recognised more often than targets presented only once. It is an interesting effect, as it may suggest that with increased time between training and recognition, the probability of correct recognition will increase. However, this effect is observed only after completion of the liking task, the overall probability of recognition is small, and in general the recognition of targets presented five times was not different from chance level. Thus, it is quite possible that this effect is an artefact of the analysis.

As in Experiment 2, the analysis of preferences was repeated with by-stimulus aggregation and comparison of differences in liking between stimuli (target and foils) with different number of exposures. In contrast to the finding obtained in Experiment 2, a one-way ANOVA demonstrated a significant effect of Exposure Frequency, $F(2, 357) = 4.34$, $p = .014$. As is evident from Figure 6, the difference between recognised and non-recognised items was significantly above zero at each frequency level, but the effect was stronger for targets presented five times than for targets presented only once, $t(227.4) = -2.18$, $p = .03$, and foils, $t(197.5) = -2.64$, $p = .009$.

Discussion

The main aim of Experiment 3 was to replicate the pattern of post-decisional preferences observed in Experiment 2. Indeed, similar results were obtained: Recognised items presented five times were selected more often than recognised items presented only once; non-recognised items presented five times were chosen less often than non-recognised items presented once; and, recognition of targets presented five times had a stronger influence on preferences than recognition of foils. Moreover, as well as in Experiment 2, the different effect of choice in the first task on choice in the second task for higher exposure frequency was evident only when preference task was preceded by recognition task, and not the other way around.

These results provide further support for the hypothesis testing account, as its predictions are in agreement with the observed pattern of results. Specifically, there is a predicted interaction between recognition of item and its objective familiarity, and it exists only when recognition task precedes preference task. The obtained findings are in partial agreement with the uncertainty reduction model, as the effect of recognition decision on preferences was positive. However, this model cannot explain the increasing effect of recognition on preferences for higher level of exposure frequency. Finally, the results provide little support for the fluency attribution account, as it predicts a negative effect of recognition on preferences, and exactly the opposite was observed.

The present experiment also aimed to validate whether the absence of mere exposure in Experiment 2 could be attributed to predominance of an analytic strategy of processing (Whittlesea & Price, 2001) due to the distinctive nature of face stimuli or due to the participants' awareness of the recognition procedure. Instruction type (expected vs. surprise recognition test) did not significantly influence recognition accuracy or preferences and, as in Experiment 2, the average recognition and preference probabilities for targets were at chance level. Thus, the absence of mere exposure is unlikely to be explained by the analytic processing strategy.

GENERAL DISCUSSION

The present research began with the argument that the process of testing cognitive hypotheses results in positive affect when hypotheses are consistent with available data, and negative affect when hypotheses are not consistent with available data. This affect, in turn, diffuses to objects associated with the hypotheses. This view leads to a three-factor model, which predicts that preference ratings depend not only upon recognition and objective familiarity, but also upon their interaction. Two alternative models, the fluency attribution and uncertainty reduction models, predict that objective familiarity is positively associated with liking of both recognised and non-recognised items, and that recognition will be either positively (uncertainty reduction) or negatively (fluency attribution) correlated with liking.

In order to test the predictions of the three models, the present research examined the nature of the relationship between familiarity, recognition, and preferences. A meta-analysis of published papers showed that, in line with predictions deriving from the hypothesis testing model, the effects of recognition and familiarity on preferences are not independent: the effect of recognition is stronger for objectively familiar objects compared to objectively unfamiliar objects. Predictions of the three models were further tested in three experiments.

Findings from Experiment 1 supported the hypotheses testing model: The difference in liking between recognised and non-recognised items increased with increasing stimulus exposure. In addition, in one of the experimental conditions in Experiment 1, participants were presented with the same stimuli twice, which enabled the change in liking of stimuli resulting from the second recognition decision to be measured. Analyses showed that the second recognition decision altered the previous liking of items such that liking of non-recognised items became more negative whereas liking of recognised items became more positive.

Experiment 2 attempted to disentangle the positive and negative effects of previous exposure on liking by utilising the stimuli exposure procedure described by Whittlesea and Price (2001). Findings from this experiment—which included 40 ms presentation times and no post-stimulus interval—demonstrated the absence of a mere exposure effect or above chance recognition. Nevertheless, recognised items presented frequently were evaluated more positively than recognised items presented infrequently or not presented at all. Most importantly, frequently presented non-recognised items were evaluated more negatively.

These results were replicated in Experiment 3 using a different stimulus set. Whether participants expected a recognition test or not made no difference to the findings.

These experiments provide convergent evidence in favour of the hypothesis testing model. When participants decide that an object has not been seen before, the more frequently that object is presented, the more negative is its affective evaluation. In other words, the greater the inconsistency between the available data and the participant's prediction, the more negatively the associated target object is evaluated. On the contrary, when participants correctly decide that an object has been seen before, then the more frequently that object is presented, the more positively it is evaluated.

The results obtained in the present studies provide no support for the fluency attribution model. In all three experiments, the recognition of objects did not result in less liking of objects. The results provide partial support for the uncertainty reduction model: Liking of recognised items was generally greater than liking of non-recognised items. However, this model does not predict an interaction between recognition and objective familiarity, and cannot explain why, in Experiment 1, there was no effect of recognition for foils.

Affect or something else?

One might question whether the findings obtained here reflect a "real" affective evaluation as opposed to some other kind of judgement. Is it possible that preference tasks like the Rorschach inkblot test is merely a projective test with nothing in common with "real" emotions? The author believes that the answer to this question is both "yes" and "no". On the one hand, the affective evaluation is a truly projective test as it summarises the results of innumerable possible hypotheses involving the evaluated stimuli. For example, the process of perception involves understanding what one is seeing in the face of an array of possible options. Consequently, the predictions made in the course of this process affect the preferences towards the perceived object. Thus, evaluations of objects that confirm a chosen hypothesis—that is, the chosen interpretation of the data presented—are more positive than evaluations of objects that reject a chosen hypothesis, even if several correct interpretations exist (Craver-Lemley & Bornstein, 2006). Similarly, sharp angles lead to less liking of objects (Bar & Neta, 2006) as the predictions based on the first part of an image turn out to be invalid. In a similar manner, Seamon et al. (1995) and Willems, Dedonder, and Van der Linden (2010) have demonstrated that the "impossible" three-dimensional objects, similar to those depicted in Escher's paintings, are evaluated more negatively than their "possible" counterparts.

On the other hand, the affective evaluation involved in such kinds of tests is likely to be a genuine one. Although this has not been explicitly tested in the present experiments, evidence from two sources support this claim. First, the same questions have been raised about preferences in the "mere exposure" studies which have been proven to be genuine, even in terms of their psychophysiological component (Winkielman & Cacioppo, 2001; Zajonc, 2000). Second, the opposite point of view postulates the existence of some sort of non-specific non-affective feeling, which is attributed to different judgements, including preference judgements. This is similar to the ideas of "subjective fluency" (Winkielman, Schwarz, Fazendeiro, & Reber, 2003) or "non-specific activation" (Mandler, Nakamura, & Van Zandt, 1987). However, experiments utilising the misattribution paradigm have cast doubt upon the idea of a specific "subjective fluency" (Reber, Schwarz, & Winkielman, 2004; Topolinski & Strack, 2009a, 2009b). These experiments demonstrate that when participants are provided with an opportunity to attribute their emotions to an irrelevant source, the effect of predictive context (for example, due to priming or semantic coherence) on different judgements is diminished. Other variants of attribution, including attribution of subjective fluency, do not have any influence. These studies differ from the classical studies of attribution (e.g., Schachter & Singer, 1962; Schwarz & Clore, 1983; Zillman, 1978) by showing not only that feelings can be attributed, but also by showing which feelings play a role in cognitive functioning, and which do not. According to the aforementioned studies, it is affect but not fluency that influences subsequent judgements. Thus, it is unlikely that such a kind of non-affective feeling exists or has any functional significance. In sum, the author contends that the feelings involved in the current experiments probably represent a genuine affect rather than some other kind of feeling.

Future directions

Further research is required to determine whether the findings obtained in the present research can be generalised to tasks other than recognition. According to the hypotheses testing model, provided there is a correct or consistent answer, and participants can arrive at that answer, the findings obtained here should be replicated. Thus, correct answers and errors should lead to changes in liking of associated answers not only in recognition tasks, but also in other simple cognitive tasks such as categorisation, identification, and comparison. This model also implies that affective reaction to stimuli depends upon the task that participants are trying to solve. For example, in studies of changes in preferences due to implicit learning, it will be important to determine whether participants are aware that some objects follow the implicitly learned rules whereas others do not. Provided participants do have such awareness, then classification of objects into confirming to the rules versus non-confirming should demonstrate increased liking of correctly classified objects and decreased liking for incorrect classifications.

The present account currently lacks specificity in respect to the notion of "hypothesis". However, it is unlikely that this problem can be solved purely on a theoretical basis. Generally, the framing of hypotheses should be important, even if from the logical point of view it does not matter. It is well known that our mind does not always take into account the reversibility of operations (in Piaget's sense), so "A is larger than B" and "B is smaller than A" will probably have different effects. In the former case, the hypothesis is more about A than about B—that is, A is a figure and B is a background—so the affective feedback will be attributed more to A than B; in the latter case the situation is reversed. This idea warrants empirical testing in further research.

In addition, changing the hypothesis can change the effects of pre-decisional hypothesis testing. For example, if we test the hypothesis "This is novel" instead of "This is old", then we will receive more positive affective feedback for novel objects than for old objects, and instead of a mere exposure effect a novelty effect should ensue. This could be achieved by providing participants with a context within which novelty seeking will be more effective than oldness seeking. The hypotheses testing model might also explain the distractor devaluation effect. A number of recent studies—most of which have utilised visual search tasks—have shown that attentional inhibition leads to a decrease in preferences for inhibited objects (Fenske & Raymond, 2006; Fenske, Raymond, Kessler, Westoby, & Tipper, 2005; Raymond, Fenske, & Tavassoli, 2003). From the present perspective, inhibition of distractors in visual search tasks results from testing the prediction that the distractor object is a target. The negative feedback resulting from the test of such prediction becomes associated with the distracter, in turn leading to an observed decrease in liking.

The results of Experiments 2 and 3 are particularly noteworthy: There was no recognition and no mere exposure effect, and yet preferences were dependent on the number of exposures such that recognised items increased in their liking corresponding to the number of exposures and liking for non-recognised items decreased as frequency of exposure increased. Even under conditions where forced-choice accuracy was at chance level, preferences demonstrated that information about recognised items was preserved. This finding is of particular importance in light of recent discussions about measures of awareness (e.g., Dienes, Scott, & Seth, 2010; Dienes & Seth, 2010; Overgaard, Timmermans, Sandberg, & Cleeremans, 2010; Persaud, Mcleod, & Cowey, 2007; Sandberg, Timmermans, Overgaard, & Cleeremans, 2010). Replication of the findings obtained in the present research would suggest that affect might usefully serve as an alternative source of different measures of awareness, such as confidence, wagers, "perceptual awareness", etc.

Another issue is the memory sources that underlie the recognition judgements. The present account is consistent with both double-process and single-process models (see Wixted, 2007; Yonelinas, 2002, for reviews). Given the chance accuracy in Experiments 2 and 3 it is quite likely that most of the judgements were based on "familiarity" (from a dual-process perspective) or had low confidence (from a single-process perspective). This leaves open the possibility that the pattern of results will be different in the case of judgements based on "recollection" or judgements made with high confidence. Recently, Topolinski (2012) investigated the sensorimotor contributions to preference and implicit memory judgements. Although in the present study this aspect of judgements has not been investigated, it is possible that motor simulations could play an important role in the obtained pattern of results.

A final issue that should be addressed here concerns the question of why the information about the objective familiarity of stimuli—available to participants as shown by post-decisional preferences—is not used in recognition decisions and does not lead to a direct enhancement of positive evaluations. The difference in strategies, as outlined by Whittlesea and Price (2001), is unlikely to be responsible for this phenomenon—there was no evidence in the present studies of any effect of "analytic–non analytic" manipulations. This account also fails to explain why preferences in Experiments 2 and 3 are sensitive to the interactions between recognition and objective familiarity and not sensitive to objective familiarity per se. Another option is that participants provide their answers in accordance with their expectancies of what these answers should be. In especially difficult tasks, such as the recognition of items presented briefly and without a post-stimulus interval, participants may expect chance-level recognition and thus provide answers that follow that expectancy. Although this explanation does not shed light on why the direct measure of preferences also follows the same pattern, further research that examines the role of participants' expectations is clearly warranted.

Summary

The hypotheses testing model "reduces" emotions to a "simple" process of matching hypotheses put forward by our brain. However, our everyday experiences of this process are rather different: We are so accustomed to our preferences that they blend into the background and become visible only when a breakthrough or a major failure occurs in the process of hypotheses testing. Neither "eureka" and "oops" moments happen very often. But, as Zajonc remarked, "we do not just see 'a house': We see a handsome house, an ugly house, or a pretentious house" (Zajonc, 1980, p. 154). And that "ugliness" or "pretentiousness" does not come out of nowhere—it results from a multitude of our hypotheses. In conclusion, findings from the present research support the view that emotional and cognitive processes are inseparable: Ensuing from a process of "hypotheses testing", affective evaluation can be conceptualised as a purely cognitive process; similarly, with their dependence upon emotional feedback, all cognitive processes can be conceptualised as emotional.

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