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The Fluency Amplification Model: Fluent stimuli show more intense but not evidently more positive evaluations

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Abstract

Processing fluency plays a large role in forming judgments, as research repeatedly shows. According to the Hedonic Fluency Model, more fluently processed stimuli are rated more affectively positive than less fluently processed stimuli. Most research documenting such findings uses neutral or positive stimuli with low complexity, thus any potential impact of initial stimulus valence cannot be tested. In the present study, 60 IAPS stimuli ranging from very negative to very positive valence were rated on liking by participants. Processing fluency was manipulated through perceptual priming (7 ms). Results of Experiment 1 (N = 35) support the prediction of the Hedonic Fluency Model, but only for stimuli with an initially positive valence. However, when negative stimuli were processed more fluently, they were rated as more negative than when processed less fluently. Experiment 2 (N = 39) showed that enhancing the accessibility of the stimulus content (via prolonging the prime duration to 100 ms) cannot account for the results of Experiment 1, since Experiment 2 failed to replicate the findings obtained in Experiment 1. Potential factors influencing affective evaluation of negative stimuli are discussed. A model is offered for the reinterpretation of processing fluency as an amplifying factor for evaluative judgment.

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Introduction

In the domain of aesthetic research it is often claimed that aesthetic pleasure is a function of the perceiver's processing dynamics. One characteristic of stimulus processing is known as processing fluency, which refers to the speed or ease with which information is extracted from a stimulus (Jacoby & Whitehouse, 1989; Reber, Schwarz, & Winkielman, 2004; Reber, Wurtz, & Zimmermann, 2004; Schwarz & Clore, 2006; Whittlesea, 1993). Research has repeatedly demonstrated that people draw on the subjective experience of processing fluency while making judgments such as truth (e.g. Reber & Schwarz, 1999), familiarity (e.g. Jacoby & Whitehouse, 1989; Whittlesea, 1993), fame (e.g. Jacoby, Kelley, Brown, & Jasechko, 1989), category membership (Oppenheimer & Frank, 2008), and especially liking (e.g. Belke, Leder, Strobach, & Carbon, 2010; Reber, Winkielman, & Schwarz, 1998; Winkielman & Cacioppo, 2001). During the 1980s, processing fluency was thought to affect various judgments about stimuli in a two-step processing procedure (e.g. Jacoby, Kelley, & Dywan, 1989; Mandler, Nakamura, & van Zandt, 1987), basically similar to the assumptions of the two-factor theory of emotion by Schachter and Singer (1962): In the first step, manipulation of processing fluency leads to an "unspecific activation" (Mandler et al., 1987) or an "arousal-like experience" (Jacoby, Kelley, & Dywan, 1989), which is affectively neutral. In the second step, the unspecific impact of processing fluency is attributed to the most obvious source of this "unspecific activation" or "arousal-like experience", which is usually the stimulus itself. Stimulus-relevant features (e.g. pleasantness) and the situational context (e.g. affective rating task) serve as the basis for attribution (e.g. towards the pleasantness of the stimulus). Processing fluency would therefore be able to affect different stimulus dimensions in different directions. Mandler et al. (1987), for example, showed that stimuli were judged as more pleasant, lighter, and darker depending on the respective task. These findings, however, could not be replicated (see Seamon, McKenna, & Binder, 1998). Similar effects were observed in the realm of research around the “mere-exposure” effect (Zajonc, 1968): Brickman, Redfield, Harrison, and Crandall (1972) reported increasing preference for initially neutrally or positively rated abstract paintings as a function of exposure. For initially negatively rated paintings, however, the affective ratings as a function of exposure decreased. Moreover, Grush (1976) found that affectively positive words become more positive with increased exposure, whereas affectively negative words become more negative.

Current research mainly assumes that high processing fluency leads to increased positive affective judgments of the assessed stimuli. More precisely, according to the Hedonic Fluency Model (Winkielman, Schwarz, Fazendeiro, & Reber, 2003), the increasing perceptual fluency of a stimulus leads to higher positive judgments about said stimulus, mediated through the affect (fluency-affect link). As a reason for this prediction, the authors state that a hedonic quality of processing fluency (Winkielman et al., 2003) itself influences the affective state of a person. The affect, in return, serves as an information aid in the judgment (Schwarz & Clore, 1983, 2006). There is strong evidence for this prediction, as compatible data patterns have been repeatedly revealed and replicated by a large series of studies (see Alter & Oppenheimer, 2009; Reber, Schwarz, et al., 2004, for reviews).

Despite these findings, many research studies on perceptual fluency concerning the fluency-affect link also show certain limitations: The stimuli used in the affective judgment tasks are mostly very simple and artificial (see, for example, Griffiths & Mitchell, 2008; Reber et al., 1998; Winkielman, Halberstadt, Fazendeiro, & Catty, 2006). As Reber, Schwarz, et al. (2004) noted, the use of low-complex stimuli may reduce the strength of a fluency-based experience: If the perceiver is able to form accurate processing expectations (e.g. due to the mere simplicity of stimuli), the source of processing fluency may become obvious, reducing the likelihood of attributing the fluency-based experience to the preference of the stimulus.

Most such stimuli of low complexity used in several studies are affectively neutral; in some cases they are slightly or clearly positive. This is quite problematic when testing the specific hypothesis that more fluency means better liking of the regarding stimuli, because the results could also be interpreted in a straightforward way as the affective quality of a stimulus merely being amplified by processing fluency. To our knowledge, there is no published work in which stimuli systematically varied in valence are tested in terms of the Hedonic Fluency Model (Winkielman et al., 2003).

Present study

To address the questions above, we aimed to re-test the assumptions of the Hedonic Fluency Model (Winkielman et al., 2003) with two specific novelties: Firstly, we aimed at using more complex stimulus material, i.e. photographic images of different scenes (people, animals, objects). We chose the IAPS database for stimulus selection (Lang, Bradley, & Cuthbert, 2005). Secondly, the present study served to explore the role of the stimulus valence as a so-far unrecognized factor. Therefore, stimuli with a wide range of valence including positive-, neutral-, or negative-inducing affect were applied. For manipulation of the processing fluency, a perceptual priming paradigm was applied.

Pre-study 1

To ensure perceptual priming affecting the perception of the IAPS stimulus material, Pre-study 1 served as a manipulation check. Since the time taken to recognise a stimulus is the common measure for its processing fluency, we applied a cover task in order to measure the time needed for people to recognise the targets: Matching (high fluency condition) and non-matching (low fluency condition) primes and targets were presented either upright or inverted to the participants, who were then asked to judge the orientation of the targets. Their reaction time served as a measure for the processing fluency of the target.

Methods

Participants. Ten undergraduates of the University of Bamberg (1 male, mean age = 24.4 yrs, range 19–38 yrs) participated in Pre-study 1. All of them had normal or corrected-to-normal vision and were naïve to the purpose of the study.

Stimulus material. Sixty stimuli fulfilling certain criteria were selected from the IAPS database (Lang et al., 2005). The selection criteria are displayed in Table 1. The Appendix shows the IAPS picture codes of the stimuli.

Insert Table 1 about here

From all stimuli, primes were derived showing only the contours of the original pictures. To decrease the visibility of the primes, the background behind the black contours was set to RGB (192, 192, 192) value grey, which corresponded to the background colour of the screen in the experiment.

Apparatus. Pre-study 1 was realised with PsyScope X53 (Cohen, MacWhinney, Flatt, & Provost, 1993) on Apple eMac computers. Primes and targets were presented on a 17-inch monitor at a size of 600 x 400 pixels. The screen resolution amounted to 640 x 480 pixels; the refresh rate 138 Hz. In order to avoid eye fatigue, the background colour of the screen was set to RGB (192, 192, 192) value grey. Input was recorded via Cedrus USB button box (precision of RT recording < 1 ms).

Procedure. Pre-study 1 consisted of 2 consecutive parts. In the first part, IAPS primes (100 ms) and targets (shown until button press; SOA = 200 ms) were presented to the participants either upright or inverted in randomised order. Primes and targets could either fit in their orientation or not; moreover, primes and targets could either be identical (high fluency condition) or not (low fluency condition), resulting in a 2 (prime upright or inverted) x 2 (target upright or inverted) x 2 (processing fluency condition) balanced within-subjects design. In total, the first part of Pre-study 1 consisted in 480 trials for each participant. Participants were asked to judge the orientation of the targets as fast as possible (task: “Is the displayed picture upright or inverted?”; German: “Ist das gezeigte Bild aufrecht oder invertiert?”). In the second part of Pre-study 1, the valences of the 60 targets were assessed on a 6-point Likert scale, asking the participants “Is the displayed picture very repulsive or very attractive?” (German: “Ist das gezeigt Bild sehr abstoßend oder sehr anziehend?”).

Results and Discussion

Since we were interested in the difference between the high and low fluency condition, only the upright prime and target combinations were analysed. A stimulus-based[1], two-tailed *t*-test for the 60 stimuli in the high fluency vs. the low fluency condition revealed significantly shorter reaction times towards stimuli presented in the high fluency condition than in the low fluency condition, $t(59) = 1.74$, $p = .044$, $d = .22$. These results show perceptual priming to be a suitable method for manipulating the processing fluency of IAPS stimuli. The ratings of the target valences show a fit to 5 categories of valence from category 1 = “very repulsive” to category 5 = “very attractive”, with 12 targets in each category of target valence. The valence ratings of the targets indeed reveal a balanced distribution through all grades of valence (see Table 2).

Pre-study 2

Although we aimed to use more complex stimulus material in the present study than is usually done in experiments on processing fluency, the IAPS stimulus material (Lang et al., 2005) is far more complex than mere geometric shapes and simple line drawings. To ensure moderate complexity of the stimulus material, targets were assessed with respect to this factor in a second pre-study.

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[1] In the present study, we were particularly interested in differences concerning the evaluation of specific targets in different fluency conditions (high vs. low fluency). For that reason, all analyses in the present study are conducted in a stimulus-based way. Outlier exclusion was done participant-based by calculating individual participant’s mean and *SD*s.

Methods

Participants. Eleven undergraduates of the University of Bamberg (1 male, mean age = 22.7 yrs, range 19–30 yrs) participated in Pre-study 2. All of them had normal or corrected-to-normal vision and were naïve to the purpose of the study.

Stimulus material. In Pre-study 2, the same targets were used as described in Pre-study 1.

Apparatus. The apparatus and its properties were the same as described in Pre-study 1.

Procedure. The targets were presented to the participants in randomised order with unlimited presentation time. For each target, participants were asked to rate its complexity on a 6-point Likert scale spontaneously, with 1 = "sparsely complex" to 6 = "highly complex". The wording of the task was "How complex is the picture to you?" (in German: "Wie complex wirkt das Bild auf Dich?"). To make sure that the targets can realistically be assessed in terms of subjective complexity, participants were asked to name the picture they were exposed to before judging its complexity (the analyses of the naming are not part of the present study).

Results and Discussion

The ratings averaged $M = 2.9$, $SD = 1.5$, which demonstrates a moderate complexity of the targets with a relatively wide range.

Experiment 1

Considering the findings of Pre-studies 1 and 2, the stimulus material selected from the IAPS database (Lang et al., 2005) is suitable for re-testing the assumptions of the Hedonic Fluency Model (Winkielman et al., 2003). Experiment 1 served to find out if the relatively high processing fluency of a target enhances its appreciation independent of the target's valence and under conditions of relatively high stimulus complexity.

Methods

Participants. Thirty-five persons (10 male, mean age = 28.3 yrs, range 19–51 yrs) participated in the experiment. Twenty-nine of them were undergraduates of the University of

Bamberg, four were graduates, and one a worker. All of them had normal or corrected-to-normal vision and were naïve to the purpose of the study.

Stimulus material. In Experiment 1, the same primes and targets were used as described in Pre-study 1. The high fluency condition contained matching primes and targets, the condition of low fluency was realised through randomly assigning a non-matching prime to a target.

Apparatus. The apparatus and its properties were the same as described in Pre-study 1.

Procedure. Sixty primes, displayed for 7 ms (exactly: 7.24 ms, corresponding to 1 frame), and targets (1,000 ms; SOA = 507 ms) were shown twice in the high fluency condition and the low fluency condition, (120 trials in total). When incorporating the five categories of valence to which the targets were assigned in Pre-study 1, the result is a 2 (*processing fluency condition*) x 5 (*category of target valence*) within-subjects design. Participants were asked to assess their affective reaction as quickly and accurately as possible on a 6-point Likert scale from 1 = "very negative" to 6 = "very positive". The task wording was "How does the picture affect you?" (in German: "Wie wirkt dieses Bild auf Dich?"). We used this neutral wording instead of a formulation like "How much do you like the picture?" to avoid pre-setting a norm. Furthermore, we aimed to establish a feeling of being personally affected by the task. Regarding answers might not only assess liking but also associated concepts such as valence. Due to the fact that changes in the processing fluency of a stimulus could lead to changes in a wide variety of judgments (e.g. attractiveness, Winkielman et al., 2006), according changes in, e.g. the valence of stimuli, are thus not susceptible of diminishing possible findings.

Statistical processing. Affective ratings of all trials were analysed by a stimulus-based two-way mixed design Analysis of Variance (ANOVA) with repeated measurements with *category of target valence* (1 = "very negative" to 5 = "very positive") as between-stimulus factor and *processing fluency condition* (high vs. low fluency) as within-stimulus factor.

Results

Means and standard deviations are displayed in Table 2. Results firstly showed a significant main effect of *category of target valence*, with regard to a strong association between the valence judgment and the affective judgment, $F(4,55) = 92.53$, $p < .001$, $\eta_p^2 = .871$. In spite of what one would expect, there was no significant main effect of *processing fluency condition*, $F(1,55) = 1.93$, $p = .170$, *n.s.* However, a significant interaction effect between the factors *processing fluency condition* and *category of target valence* was obtained (see Figure 1), $F(4,55) = 3.83$, $p = .008$, $\eta_p^2 = .218$. Simple main effects revealed differences between the high and the low fluency condition in the categories of target valence "very negative" ($p = .041$, $\eta_p^2 = .074$), "mildly positive" ($p = .037$ $\eta_p^2 = .077$) and "very positive" ($p = .011$, $\eta_p^2 = .106$). As shown in Figure 1, positive targets with a *category of target valence* "mildly positive" or "very positive" were rated higher in liking in the high fluency condition than in the low fluency condition. Targets in the "very negative" category of valence (*category of target valence* = 1) were rated lower in liking in the high fluency condition than in the low fluency condition.

Insert Figure 1 about here

To get further insights into the mechanisms which account for the interaction effect between the factors *processing fluency condition* and *category of target valence,* we investigated the role of the valence of prime. If the valence of prime (more specifically: affective priming) has an influence on the liking ratings, the ratings in the trials with low processing fluency, i.e. non-matching prime-target combinations should systematically vary with the valence of the primes. We conducted another Analysis of Variance (ANOVA) with repeated measurements with *category of target valence* (1 = "very negative" to 5 = "very positive") as between-stimulus factor and *category of prime valence* (1 = "very negative" to 5 = "very positive") as within-stimulus factor. Only the trials in the low fluency condition were analysed. Results revealed neither a significant effect of *category of prime valence*, $F(4,220) = 1.38$, $p = .242$, *n.s.*, nor an interaction effect of *category of target valence* and *category of prime valence*, $F(16,220) = .82$, $p = .658$, *n.s.* A significant effect of *category of target valence* occurred, $F(1,55) = 2703.29$, $p < .001$, $\eta_p^2 = .980$ due to the strong association between the valence judgment and the affective judgment.

Discussion

Experiment 1 is a classical processing fluency experiment, with the added innovative element of using relatively complex stimuli with a wide range of valence. Results were in accordance with the predictions of the Hedonic Fluency Model for positive stimuli; i.e. highly fluent targets are liked more than targets of low processing fluency. Unexpectedly, no processing fluency effect in terms of the Hedonic Fluency Model occurred for neutral stimuli, and results for negative targets even contradicted the predictions of the Hedonic Fluency Model because highly fluent targets in the lowest *category of target valence* are liked *less* than targets of low processing fluency.

One possible reason for this might be that the differences in liking between the low fluency and the high fluency condition are due to affective differences instead of differences in processing fluency. Since the IAPS primes do also have a valence and are randomly chosen from the whole set of primes in the low fluency condition, the prime valence can be affectively similar (although perceptually different) to the target — or the prime can differ in a positive or negative direction. To rule out the argument that affective priming accounts for the results of Experiment 1, another analysis was conducted. The results show that the valence of prime does not affect the liking ratings. We therefore conclude that the results of experiment 1 do indeed indicate effects of processing fluency.

Experiment 2

Reber, Schwarz, et al. (2004) discussed the role of stimulus valence in terms of processing fluency in the context of mere-exposure research, as only studies in this area have so far reflected findings with stimulus material of different valences. Accordingly, “reversed” mere-exposure effects of initially negative stimuli decreasing in preference with subsequent exposure (e.g. Brickman et al., 1972; Grush, 1976, as already mentioned above) do not reflect effects of processing fluency (Reber, Schwarz, et al., 2004). Rather, the repeated exposure to a stimulus could enhance the accessibility of the stimulus content. The resulting affective response — especially for negative stimuli — may outweigh any initial positive reaction due to processing fluency (Reber, Schwarz, et al., 2004), as people draw on feelings as a source of information when forming evaluative judgments (Schwarz & Clore, 1983, 2006). We therefore aimed to test this hypothesis experimentally by replicating the present study and facilitating the accessibility of the target content by presenting the prime for 100 ms instead of 7 ms.

Methods

Participants. Forty undergraduates of the University of Bamberg (N = 39; one data file had to be removed due to a record error; 6 male, mean age = 22.1 yrs, range 18–39 yrs) participated in the experiment. All of them had normal or corrected-to-normal vision and were naïve to the purpose of the study.

Stimulus material. In Experiment 2, the same primes and targets were used as described in Pre-study 1. The high fluency condition again contained matching primes and targets, the condition of low processing fluency was realised through randomly assigning a non-matching prime to a target.

Apparatus. The apparatus and its properties again were the same as described in Pre-study 1.

Procedure. The procedure was the same as in Experiment 1 with a few differences. The primes were presented for 100 ms to increase facilitating the accessibility of the target content in the high fluency condition. The SOA was 200 ms and the targets were shown until the button was pressed. Again, primes and targets were shown twice in the high fluency and in the low fluency condition (120 trials in total), resulting in a 2 (*processing fluency condition*) x

5 (*category of target valence*) within-subjects design. To check the visibility of the priming, persons were asked if they had seen the primes after participating in Experiment 2.

Statistical processing. Affective ratings of all trials were again analysed by a stimulus-based two-way mixed design Analysis of Variance (ANOVA) with repeated measurements with *category of target valence* (1 = "very negative" to 5 = "very positive") as between-stimulus factor and *processing fluency condition* (high vs. low fluency) as within-stimulus factor.

Results

Means and standard deviations are displayed in Table 2. Results revealed a significant effect of *category of target valence*, $F(4,55) = 134.91$, $p < .001$, $\eta_p^2 = .908$, but no significant interaction between *category of target valence* and *processing fluency condition*, $F(4,55) = 1.44$, $p = .232$, *n.s.* A small effect of *processing fluency condition* occurred, $F(1,55) = 4.70$, $p = .034$, $\eta_p^2 = .079$. Simple main effects, however, revealed only a significant difference in the highest category of target valence "very positive" ($p = .006$), with targets in the high fluency condition being liked more than targets in the low fluency condition. Regarding the self-statements about the visibility of the primes, only eleven out of thirty-nine participants claimed not to have seen the primes during the experimental procedure.

Insert Table 2 about here

Discussion

According to Reber, Schwarz, et al. (2004), increased accessibility of the target content should increase or at least replicate the findings of Experiment 1 with regard to the negative categories of valence. The results, however, do not support the argument for increased accessibility of the stimulus content being accountable for "reversed" effects contradicting the Hedonic Fluency Model. Instead, the results suggest that the findings of Experiment 1 do indeed reflect genuine effects of processing fluency: With a brief prime (7 ms) in Experiment

1, processing fluency effects on liking were obtained, both for targets with initially positive and negative valence. In Experiment 2, however, twenty-eight out of thirty-nine participants stated in a post-hoc feedback session that they had seen the primes preceding the targets. Accordingly, one could argue that making the source of processing fluency more obvious by prolonging the prime duration (as was done in Experiment 2) reduced the effects of changes in processing fluency on liking, mostly to non-significance. Similar findings were reported by Bornstein and D'Agostino (1994) and Van den Bergh and Vrana (1998), who found the impact of processing fluency effects on liking of the stimuli to be moderated by attributional processes: when it was possible for participants to attribute processing fluency to another source besides liking, the probability of higher evaluations in the high fluency condition decreased (Bornstein & D'Agostino, 1994; Van den Bergh & Vrana, 1998).

General Discussion

The present study tested the predictions of the Hedonic Fluency Model (Winkielman et al., 2003), i.e. the impact of processing fluency on liking. In addition to the common practice of already published research, we explicitly used stimulus material with a wide range of valence, actually ranging from being very positive to very negative. The findings only support the predictions of the Hedonic Fluency Model for targets with a positive valence. Targets with a neutral or negative valence, however, are not liked more in the high fluency condition. Moreover, targets with a strong negative valence are liked less in the high fluency condition. The effect size of the result is moderate, but indeed comparable to some of the most cited studies on processing fluency effects in affective judgments (see Table 3). None of the studies reported simple main effects for the different grades of the scale used within the experiments, as we did. And only in two papers are effect sizes reported, albeit for only one experiment each (Reber et al., 1998; Winkielman et al., 2006).

Insert Table 3 about here

Since no study investigated the role of stimulus valence in the research on processing fluency, the motivation of the authors of the present study was to extend the approach of the Hedonic Fluency Model, especially by applying stimuli with a negative valence. It seems surprising, however, that even stimuli with a "neutral" valence did not lead to findings consistent with the predictions of the Hedonic Fluency Model. Our findings are rather interpretable in the sense of two-step accounts (e.g. Jacoby, Kelley, & Dywan, 1989; Mandler et al., 1987), which state that processing fluency causes an unspecific, i.e. affectively neutral activation (1st step), which is attributed towards the target valence as the most obvious source of this activation (2nd step). Under fluent conditions, targets with a positive valence are judged more positively, whereas initially negative targets are judged even more negatively. Targets with a neutral valence should not be judged more positive under fluent conditions, as shown in the present study. More specifically, the experience of processing fluency seems to *amplify* the affective reaction induced by a target. Hence, we would like to propose a much more simple explanation for the processing fluency effect which we would like to call the "Fluency Amplification Model" (FAM; see Figure 2 for illustration).

Insert Figure 2 about here

According to the FAM, the processing fluency of a stimulus amplifies its valence the more intensive the valence of the stimulus is, which is in line with the findings of the present study. But why do experiments on processing fluency consistently report more positive judgments under fluent conditions, although neutral stimuli are used? One reason could be that the stimuli used in typical studies on processing fluency often stem from object classes that could not in fact be neutral, but rather show inherent qualities of being of mildly positive in their valence, e.g. faces (Bornstein & D'Agostino, 1994; Harmon-Jones & Allen, 2001) or line-drawings (Forster, Leder, & Ansorge, 2013; Griffiths & Mitchell, 2008; Reber et al., 1998) such as introduced by Snodgrass and Vanderwart (1980), which are easily recognisable and often highly prototypical for the objects they are depicting. In this case, processing fluency does not itself need to be of hedonic quality to produce the typical findings of more positive evaluations under fluent condition. Instead, they can be interpreted in terms of the FAM. There are, however, studies in which other stimulus types were used, e.g. circles differing in contrast (Reber et al., 1998), square patterns (Reber et al., 1998), or dot patterns (Reber et al., 1998; Winkielman et al., 2006), which are less likely to have a positive valence. Nevertheless, in general, valence ratings for the stimuli are hardly provided. In the present study, however, the valence of the stimuli is pre-assessed and explicitly considered in the experiments as neutral stimuli are clearly assigned to a neutral category of valence. Hence, there is clear evidence for the stimuli having a neutral valence.

Besides the valences of the stimuli, also the valences of primes (especially in the low fluency condition) could potentially influence liking ratings in terms of affective priming (and account for the findings obtained in Experiment 1). A clear distinction between effects of affective priming and effects in terms of the FAM is therefore needed: Affective priming facilitates the processing of a subsequent stimulus and causes a faster and more accurate reaction on the stimulus if the prime and the stimulus show an affective congruency (Klauer & Musch, 2003). The FAM predicts a faster and more intensive reaction on a stimulus if the prime and the stimulus show *perceptual* congruency (i.e. high processing fluency; effects caused by conceptual congruency have not been tested, yet). Amplification of liking ratings should therefore only occur in trials with perceptual, but not in trials with affective prime-target-congruency only. This was indeed the case in Experiment 1, qualifying the results as based on genuine processing fluency effects in accordance with the predictions of the FAM.

Contrary to the hypothesis stated by Reber, Schwarz, et al. (2004) that increased accessibility of the stimulus content could account for the findings of the present study especially for targets with a negative valence, Experiment 2 showed that increasing the accessibility of the target content did not intensify the findings of Experiment 1. Reber, Schwarz, et al. (2004) urge another argument for the notion that initially negative stimuli decreasing in preference with subsequent exposure do not reflect effects of fluency: Fluent processing of negative stimuli may prompt evaluations via meta-cognitive inferences (Skurnik, Schwarz, & Winkielman, 2000). Reber, Schwarz, et al. (2004) advocate this argument on mere-exposure research. In the present study, however, a perceptual priming paradigm was used for the manipulation of processing fluency. Hence, the possible gain of information derived from the target is thought to be much lower between the low and the high fluency condition than it is in mere-exposure experiments. In any case, a prolongation of the prime duration (as was done in the additional experiment mentioned above) neither amplified nor replicated the findings of the present study. Another argument of Reber, Schwarz, et al. (2004) states the valence of the context as being able to influence judgments in evaluation tasks. As we were interested in reducing the potential to attribute the experience of processing fluency to alternative sources besides the targets, the experiment was realised in a laboratory. Hence, the situation had been controlled for possible intervening factors. Moreover, the targets in the present study were shown in a randomised order, which means that the participants were also confronted with different valences in a randomised order. A context effect would have had impacts on all judgments, not only specifically on the judgments concerning targets with initially negative valences. The fact that we obtained increased affective evaluations for positive as well as negative targets speaks in favour of an amplifying effect of processing fluency.

Conclusion

Research shows a long history of empirical evidence that the processing fluency of a stimulus can influence a variety of judgments. In studies concerning affective evaluations, the experience of processing fluency is usually thought to be affectively positive, which is concluded from evidence mostly based on affectively neutral and artificial stimulus material (an exception is the study of Belke et al. (2010), although the stimuli were artworks and therefore very specific; see also Bornstein (1989) for the specific status and type of processing of artworks). The present study made the effort to extend the existing evidence by using relatively complex stimulus material with a wide range of valence. The findings offer the reinterpretation of processing fluency as an “amplifier” for evaluative judgment in the sense of the here introduced “Fluency Amplification Model” (FAM), which gives rise to several questions. Firstly, what about the affective quality of processing fluency? The Hedonic Fluency Model (Winkielman et al., 2003) assumes a hedonic quality of processing fluency, but the findings of the present study show contrary effects for negative stimuli. More research with systematic testing of stimulus valence in terms of processing fluency is needed. Secondly, could arousal play a role in explaining the different findings with regard to processing fluency in affective judgments? In the present study, besides neutral stimuli, stimuli with particularly high affective value were used. According to Storbeck and Clore (2008), arousal can represent variations in the amplitude of emotional responses and therefore lead to intensified judgments depending on affective valence. Hence, amplified affective evaluations of highly fluent stimuli could be due to intensified arousal. To explore the role of arousal in regard to processing fluency, both valence and arousal should be balanced across stimuli in affective judgment tasks. A third question concerns the nature of evaluation tasks used in studies investigating processing fluency. As evaluative judgments could be influenced by culture, past experience or expectations, they may not reflect genuine affective responses to such an extent and effects of processing fluency could be diminished or outshined (Makin, Pecchinenda, & Bertamini, 2012). As shown in several experiments (Olds & Westerman, 2012; Unkelbach, 2006, 2007), it is even possible to produce (apparently) reversed fluency effects through training. A way around the problem could be physiological measures, e.g. facial electromyography (EMG; see, for example, Winkielman & Cacioppo, 2001). Another promising strategy is being pursued by Makin et al. (2012), who has detected processing fluency effects in the appreciation of symmetrical dot patterns employing the Implicit Association Test (IAT). As processing fluency effects on judgments are complex and not restricted to a straightforward positive cue toward judgment (Oppenheimer, 2008), further research is needed to fathom the nature of processing fluency and its effects on judgment.

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Appendix

IAPS picture codes

Complete list of the IAPS Picture codes of the stimuli used in the present study, split by categories of target valence (1 = "very repulsive", 5 = "very attractive").

Category of target valence	1	2	3	4	5
IAPS Picture codes	3261	1321	7450	1333	1722
	9600	1110	7175	1661	1463
	2720	2120	1560	2191	1460
	3266	9270	7025	7325	1920
	3000	2053	2661	8510	4574
	3400	9560	7235	1740	7340
	1525	2900	7010	7057	2040
	9571	9000	7039	1450	4645
	9561	3160	7950	7090	1441
	6570	7359	7705	2650	1812
	3061	7038	7009	7460	1750
	1201	3350	9070	1999	2058

Tables

Table 1. *Procedure for stimulus selection from the IAPS database (Lang et al., 2005).*

Criteria		Explanation
1st step	Valence	Generally, pictures with a wide range of valence were selected.
2nd step	Sexual-related content	Pictures with sexual-related content were excluded in general.
3rd step	Complexity	Pictures with high complexity (e.g. pictures displaying scenes with more than two people interacting) were excluded to ensure clear and spontaneous evaluations.
4th step	Unambiguity of orientation	Pictures with ambiguous orientation were excluded (e.g. pictures displaying aerial views). Moreover, pictures displaying a horizon were excluded in order to avoid resolving the orientation task of Pre-study 1 without encoding the picture's contents.
In cases of similar picture content:		
5th step	Quality	Pictures with relatively low viewing quality (e.g. dark pictures with relatively low figure-ground contrast) were excluded.
6th step	Intensity	In cases of pictures with highly positive or negative valences, the picture with the most intense valence was chosen.

Table 2. *Means (M) of the valences of the targets obtained in Pre-study 1; means and standard deviations (SD) of liking ratings in Experiment 1 and 2. Significant effects of the condition (high vs. low fluency) are indicated by an asterisk.*

Pre-study 1		Experiment 1				Experiment 2			
Target valences		Liking ratings depending on processing fluency condition				Liking ratings depending on processing fluency condition			
		High fluency		Low fluency		High fluency		Low fluency	
Category	*M*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	1.44	1.60*	0.64	1.68*	0.63	1.38	.45	1.35	0.43
2	2.62	2.46	0.64	2.49	0.65	2.21	.58	2.22	0.55
3	3.75	3.56	0.42	3.52	0.36	3.51	.47	3.50	0.44
4	4.37	4.46*	0.51	4.38*	0.47	4.50	.65	4.48	0.63
5	5.42	5.08*	0.22	4.99*	0.20	5.45*	.26	5.37*	0.32

*$p < .05$

Table 3. *Most cited studies on processing fluency (main) effects on affective judgments as of 13th January, 2014.*

Paper	Times cited	No. of exp.	Effect	Effect size	Remarks
Reber et al. (1998)	258	1	Line drawings preceded by matching primes were judged prettier than drawings preceded by mismatching primes	Effect of priming on prettiness ratings: *d* = 0.241	
		2	High-contrast circles were liked more than low-contrast circles	Effect of contrast on prettiness ratings: $R^2 = .747$[1] (white background), $R^2 = .936$[1] (black background) Effect of contrast on ugliness ratings: $R^2 = .238$[1] (white background)	Effect sizes are strong; however, as it does not seem plausible to ask about the prettiness and ugliness of circles, participants could have figured out the task in the sense of linking their ratings to the figure-ground-contrast of the stimuli.
		3	With increasing presentation time, black-and-white square patterns were liked more, disliking decreased.	Effect of presentation time on liking ratings: $\eta_p^2 = .244$ Effect of presentation time on disliking ratings: $\eta_p^2 = .219$	
Winkielman and Cacioppo (2001)	248	1	Line drawings preceded by matching primes produced higher liking ratings and greater activity of the zygomaticus	Effect of priming on activity of zygomaticus: $\eta_p^2 = .474$ Effect of priming on liking ratings: *d* = .693 No effect of priming on disliking ratings	In the procedure, no ISI between the prime offset and the stimulus onset is mentioned. In this case, it is not ensured that both are singularly perceived by the participants.
		2	Increasing presentation times of line drawings led to higher liking ratings and greater activity of zygomaticus	Effect of presentation time on activity of zygomaticus: $\eta_p^2 = .212$ Effect of presentation time on liking ratings: $\eta_p^2 = .154$ No effect of presentation time on disliking ratings	
Bornstein and D'Agostino (1994)	150	1	Increasing familiarity of photographs/line drawings led to higher liking ratings; attribution of familiarity on previous exposure (via instruction) led to lower liking ratings	Effect of familiarity on liking ratings: $\eta_p^2 = .256$ effect of instruction on liking ratings: $\eta_p^2 = .251$	
		2		Effect of familiarity on liking ratings: $\eta_p^2 = .421$ Effect of information on liking ratings: $\eta_p^2 = .118$	
Winkielman et al. (2006)	109	1	Increasing the proto-typicality of black-and-white dot patterns led to higher fluency	Effect of prototypicality on fluency: $\eta_p^2 = .207$ Effect of prototypicality on attractiveness ratings:	Some effect of prototypicality remained when fluency was controlled, although

			(measured through reaction time) and higher attractiveness ratings	η_p^2 = .138	there was a mediator effect of fluency concerning the effect of prototypicality on attractiveness.
		2		Effect of prototypicality on fluency: η_p^2 = .465 Effect of prototypicality on attractiveness ratings: η_p^2 = .664	
		3	Increasing familiarity of dot pattern prototypes (via previous exposure) led to higher cheek activity (EMG) and higher liking ratings	Effect of familiarity on cheek activity: η_p^2 = .19[1] Effect of familiarity on liking ratings: η_p^2 = .17[1]	
Harmon-Jones and Allen (2001)	88	1	With increasing familiarity, photographs were liked more.	Effect of familiarity on activity of zygomaticus: *d* = .147 Effect of familiarity on liking ratings: *d* = .184	

[1] Effect sizes derived from the paper. The other effect sizes are calculated by the authors of the present study following Rasch, Friese, Hofmann, and Naumann (2006): *d* was calculated for *t*-tests and η_p^2 for ANOVAs, considering differences in calculating the effect sizes depending on the specific design of the experiments, respectively.

Figure captions

Figure caption 1. Results show amplified liking ratings in the high fluency condition compared to the low fluency condition. Error bars represent ± 1 standard error of the mean (SEM), * $p < .05$, ** $p < .01$.

Figure caption 2. Illustration of the Fluency Amplification Model (FAM). Images represent sample primes and targets of the present study, each shown with high (primes match the targets) and low (primes mismatch the targets) processing fluency. Images were assigned to the categories of valence depending on the valence ratings of the targets obtained in Pre-study 1.

Figures

Figure 1.

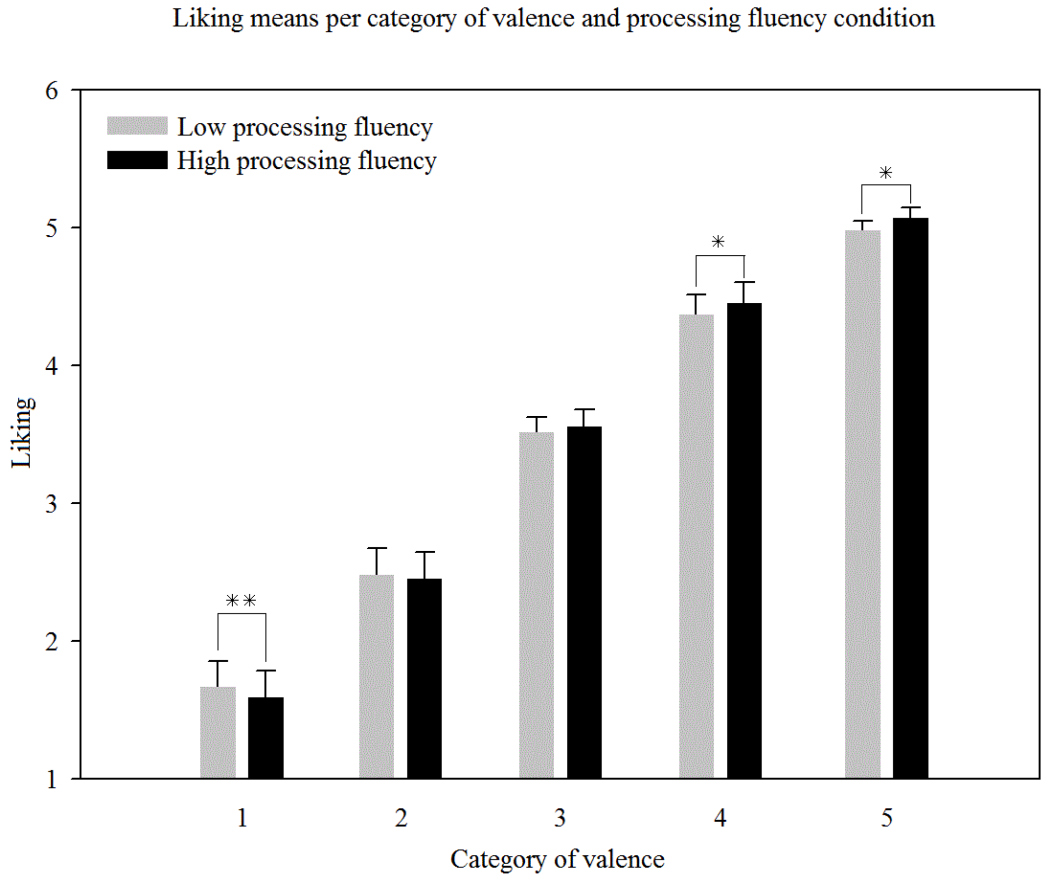
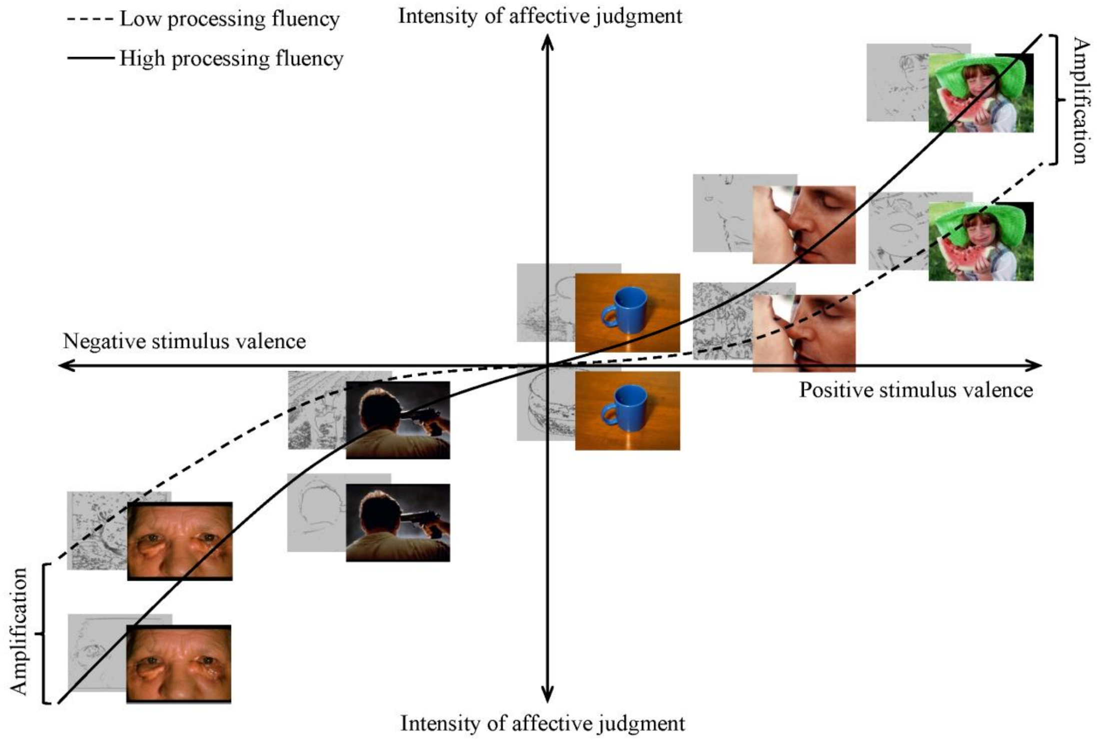


Figure 2.


Low processing fluency
High processing fluency
Intensity of affective judgment
Negative stimulus valence
Positive stimulus valence
Amplification
Amplification
Intensity of affective judgment