The Impact of Minimal Exposure to Affective Information on Mood and Its moderation by Prime Visibility: A Meta-Analysis

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Abstract

This article presents a meta-analysis of the impact of the minimal exposure to affective stimuli on the emergence of enduring conscious affective feelings. Theories often assume that such affective feelings are linked to automatic appraisals of events (i.e., in the absence of evaluative processing goal). However, few studies have tested this hypothesis. Moreover, they have provided divergent results. We propose a meta-analysis of these studies to get a clearer picture on this issue. The meta-analysis includes 22 studies (37 effect sizes; combined N = 2159) in which participants were repeatedly exposed to affective stimuli in the absence of evaluative processing goal before their mood was measured. In this analysis, we focused on the type of stimulus presentation (i.e., visible vs. masked) as well as on the type of stimulus (i.e., faces, pictures, words). The results indicate that the effect of stimulus is moderated by the visibility of the stimuli. Repeated exposure to visible stimuli leads to congruency effects (i.e., positive stimuli lead to positive feelings), whereas exposure to masked stimuli leads to contrast effects (i.e., positive stimuli lead to negative feelings). Moreover, these effects seem to be restricted to some types of stimuli, with no detectable effects of emotional faces.

Keywords: Meta-analysis, Emotion Feelings, Affect, Awareness, Mood

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The question of the emergence of affective feelings is a crucial issue in research on affective responses. Theorists often consider affective feelings as one of the most important elements in emotional (e.g., Clore, 1994; Izard, 2009; James, 1884, 1890; Keltner & Gross, 1999) as well as in mood experiences (e.g., Schwarz, 1990), the one that is supposed to guide judgment and behavior (Huntsinger et al., 2014; Schwarz, 1990; Zeelenberg & Pieters, 2006). However, it is unclear how this component develops and may lead to relatively enduring self-reported positive/negative affective feelings, which are often referred to as affect (e.g., Boyle et al., 2015; Russell, 1980) or mood (e.g., Silvestrini & Gendolla, 2011a; Winkielman et al., 2005). In response to this theoretical question, Chartrand et al. (2006) proposed that the emergence of such affective feelings could be due to automatic (i.e., unintentional and nonconscious) evaluation of the stimuli present in the individual's environment. However, to our knowledge, evidence supporting the idea that minimal exposure to affective stimuli (i.e., in the absence of evaluative processing goal) leads to the emergence of affect or mood remains limited. Only a small number of studies have provided relevant data, and their results are inconsistent. The aim of the present research was therefore to conduct a meta-analysis of relevant research to provide a clearer picture of the impact of minimal exposure to affective stimuli on such affective feelings.

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How Do Affective Feelings Emerge? The Case of Automatic-Evaluation

Studies have demonstrated that the simple presence of affective stimuli can impact numerous mental processes, such as attention (e.g., Rothermund et al., 2011), judgment (e.g., Higgins et al., 1977; Murphy & Zajonc, 1993), decision (e.g., Efendic et al., 2019; Schulreich et al., 2016) and activation of action tendencies (e.g., Rougier et al., 2018). In this research, affective feelings are often proposed as mediating the impact of affective information processing in the observed effects (e.g., Huntsinger et al., 2014; Murphy & Zajonc, 1993; Schwarz, 1990; Zeelenberg & Pieters, 2006; but see Lambie & Marcel, 2002; Winkielman et al., 1997; Winkielman et al., 2005). That is, valence extracted from the affective stimulus during the evaluation process are expected to trigger affective feelings that in turn impact mental processes (e.g., Chartrand et al., 2006). However, this affective mediation is rarely tested. For instance, it is worth noting that most of these studies did not include a measure of affective feelings. In contrast to this view, other researchers have suggested that affective feelings would not play a major role in these effects, which would instead be mediated by the activation of evaluative mental content (e.g., Blaison et al., 2012; Loersch & Payne, 2011). More generally, only a few studies have directly tested the impact of minimal exposure to minimal affective information (e.g., presentation of isolated words or pictures) on affective feelings. The research by Chartrand and colleagues (2006) is one of the rare exceptions. These authors proposed that the unconscious evaluation of affective stimuli can trigger conscious affective feelings. More precisely, they proposed that objects are automatically evaluated in order to adapt rapidly and efficiently to the environment (e.g., avoiding danger). When exposure to objects of the same valence is prolonged, the same valence is continuously activated. Such a continuous activation would then gradually trigger the emergence of diffuse (congruent) affect. Consistent with this hypothesis, Chartrand and colleagues observed that participants unconsciously exposed to 75 positive words reported more positive affective feelings (i.e., being in a better mood) than participants exposed to the same number of negative words.

However, other studies failed to observe such effects. For instance, Gendolla and colleagues (e.g., Gendolla & Silvestrini, 2011; for a review, Gendolla, 2015) demonstrated the impact of emotional faces on physiological response (e.g., cardiovascular reactivity) but did not report any effects on self-reported mood (see also, Ric, 2004; Winkielman et al., 2005).

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One potential explanation for this discrepancy is related to the visibility of the affective primes. Chartrand and colleagues used a funnel debriefing to control awareness of the primes. Such a procedure can be considered as not sufficiently conservative as participants may have been aware of the primes when they occurred, but were unwilling to report them, or still unable to do so, at the end of the experimental session (e.g., Doyen et al., 2014). Gendolla and colleagues relied on a more conservative criterion regarding participants' awareness of the primes (i.e., performance in a forced choice discrimination task), which may explain why they did not replicate the Chartrand et al.'s effects on mood. So, it is possible that the prime visibility is a necessary condition for these effects to occur.

Another possibility is related to the type of stimulus used in these studies. The primes used in the studies by Chartrand and colleagues were words whereas Gendolla and colleagues typically used pictures of emotional facial expressions as primes. This can be considered rather paradoxical since it is often assumed that pictures have more power in emotion elicitation (Rellecke et al., 2011; Winkielman & Gogolushko, 2018; but see Tempel et al., 2013). However, facial expressions are a very special type of stimulus since they present emotion expressed by someone else. Thus, it is unclear whether such pictures induce in the observer the same affective feelings as the ones expressed in the picture, or trigger complementary reactions (Blaison et al., 2012).

To explore these issues, Pillaud and Ric (2020) conducted a series of studies to directly test the impact of the visibility of the affective stimuli. They sequentially exposed participants to 110 positive or negative words (Exp. 1) or pictures (Exp. 2) presented briefly (33 ms) in a task for which these stimuli were totally irrelevant (i.e., participants had to decide whether a geometric shape presented thereafter was a square or a diamond). For half of participants, the affective stimuli were not masked and were thus visible. For the other participants, the stimuli were masked. Facial EMG on corrugator (associated to negative

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affect) and on zygomaticus muscle (associated to positive affect) were measured during the presentation of the affective stimuli. After the 110 trials, participants reported their mood (Brief Mood Introspection Scale—BMIS; Mayer & Gaschke, 1988). Moreover, these studies included a forced-choice discrimination task to evaluate participants' awareness of primes. Pillaud and Ric replicated the effect observed by Chartrand and colleagues, but only when the stimuli were visible, suggesting that affective primes require awareness to elicit affective feelings. Unexpectedly, when the stimuli were masked, the effects were reversed. The same effects were observed with words (Exp. 1) as well as with pictures (Exp. 2) as stimuli, suggesting that these effects were not moderated by the type of prime (words vs. pictures). The contrast effect observed in the masked condition was interpreted as illustrating counter-regulation processes (Rothermund, 2011; Rothermund et al., 2011). According to this theoretical position, individuals engage in goal pursuit tend to maintain a balance in their affective and motivational state in order to remain attentive to potential positive and negative outcomes. To do so, they allocate attention to objects that are opposed in valence to their current affective-motivational state. Unlike participants exposed to visible affective stimuli, participants exposed to masked stimuli could misattribute the activation of valence information to their current state. As a result, they would engage in counter-regulation processes by allocating attention to stimuli or objects of opposite valence located either in the environment, their body or their mind (e.g., memories). This would explain the contrast effect observed after exposure to masked affective stimuli by Pillaud and Ric in their two studies as well as results gathered in related research areas (e.g., Banse, 2001; Era et al., 2015; Glaser & Banaji, 1999; Hermans et al., 2003; Winkielman & Gogolushko, 2018).

These conclusions are, however, based on a very limited number of studies and remain thus speculative. In order to corroborate these findings, we proposed to conduct a meta-analysis on research in which participants were repeatedly exposed to primes of the same

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valence, in the absence of explicit processing goal regarding these primes, and in which their mood was measured. Thus, we included in this meta-analysis studies in which positive/negative affective feelings were the main dependent variables, but also studies focusing on other outcomes as long as they contained at least one measure of affective feelings (e.g., as a manipulation check). Our aim was to compare the effects of positive vs. negative stimuli on positive/negative self-reported affective feelings and to test whether these effects were moderated by prime visibility (i.e., awareness). According to Chartrand and colleagues, we expected to observe a congruency effect on affective feelings whatever the primes visibility. In contrast, in line with the results of Pillaud and Ric and with counter-regulation processes (Rothermund, 2011; Rothermund et al., 2011), we expected to observed congruency effects when the stimuli were visible but a contrast effect for masked stimuli. An ancillary aim was to test whether these effects were moderated by the type of stimuli (i.e., words, pictures, and facial expressions).

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Method

Literature Search Strategy

Several methods were used to select experiments and articles of interest for this meta-analysis:

1. An initial search was performed on PsycINFO, Scopus and Web of Science in order to find published articles relevant to our research question. We searched with the following keywords: mood AND[1] implicit affect, mood AND non-conscious AND priming, mood AND conscious AND priming, mood AND unconscious AND priming, implicit affect AND priming, implicit affect AND affect ratings, unconscious emotion, unconscious affect,

[1] "AND" refers to Boolean search operators.

affective state AND priming, affect AND priming, feeling AND implicit affect, feeling AND non-conscious AND priming, feeling AND conscious AND priming, feeling AND unconscious AND priming. All articles obtained during this research were reviewed to verify whether they met our inclusion criteria. The articles had to be written in English or French.

2. We searched in PsycINFO, Scopus and Web of Science for all the articles citing those that were selected in the database as well as all of the articles they were citing. Once again eligible studies were included in the meta-analysis.

3. If the articles did not provide effect sizes or enough information to make an estimation, the authors were contacted to obtain the information necessary for calculating effect sizes.

4. Our own unpublished data was reviewed to verify their eligibility criteria.

5. Finally, unpublished data were solicited directly from members of the European Association of Social Psychology through an e-mail to all members and a message posted on the association's social media pages.

6. When authors were contacted directly to access effect sizes not reported in the articles, they were asked if they had unpublished data that could be included in this meta-analysis.

Study Eligibility

To be included in the meta-analysis, published and unpublished articles had to meet the following criteria:

1. Participants should have been repeatedly exposed to affective stimuli (regardless of the type of stimuli—words, faces, images, sounds), either clearly visible or degraded (e.g.,

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masked) without being instructed to evaluate the valence of the stimuli. This requirement was set in order to test the theoretical explanation that affective feelings may emerge as a consequence repeated automatic (i.e., without intention to process the evaluative meaning of the stimuli, and potentially nonconsciously) evaluation of stimuli of the same valence (Chartrand et al., 2006) [Reason 1]

2. The valence of the stimuli must have been manipulated and the study should oppose stimuli of at least two different valences among positive, negative, and neutral. [Reason 2]

3. Experiments should include at least one measure of affective feelings (self-report). [Reason 3]

4. The valence of stimuli had to be manipulated between participants. [Reason 4][2]

These different elements are summarized in the PRISMA flow diagram (Figure 1). Note that there are 15 articles included but that this represents 22 studies as some articles included multiple studies that met our inclusion criteria.

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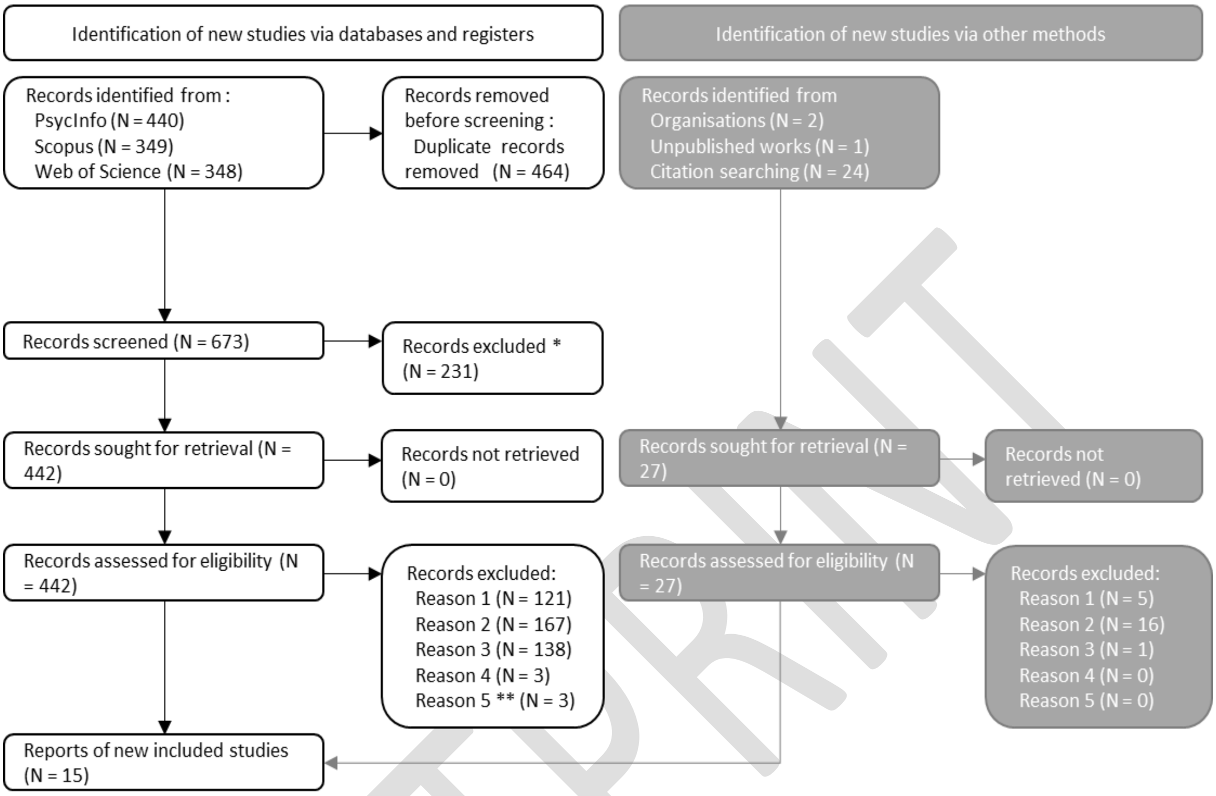
[2] In this meta-analysis, we were interested in the impact of minimal exposure to affective stimuli on the emergence of affective feelings. Therefore, we did not include studies in which participants were instructed to process such stimuli with an evaluative (or feeling) goal in mind, as such situations cannot be characterized as minimal exposure. For the same reason, we did not include within-participants designs because these designs involve repetitions of the measure. If the measures are repeated, participants are likely to process the stimuli after the first measure of affective feelings with such a processing goal in mind.

Figure 1.

PRISMA Flow Diagram for the Selection of Eligible Studies.



* Studies excluded in the screening phase were excluded because the articles were not empirical or were not written in French or English.

** Reason 5 refers to items excluded because we could not access the data to estimate the effect size.

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Effect Size Estimation

The effect sizes were estimated as *d*s (Lenhard & Lenhard, 2016). When the means, standard deviations and number of participants were provided, we relied on the following formula, $d = \frac{M_1 - M_2}{\sqrt{\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}}}$ or $d = \frac{M_1 - M_2}{\sqrt{\frac{s_1^2+s_2^2}{2}}}$. When the statistical *t* values were reported with *N*, we used the following formula (Lakens, 2013), $d = \frac{2*t}{\sqrt{N}}$. When *F* values were reported, we estimated effect sizes by η^2_p and then we converted them to *d*, $\eta_p^2 = \frac{F \times df_{effect}}{F \times df_{effect} + df_{error}}$ and $d =$

$2 \times \sqrt{\frac{\eta_p^2}{1-\eta_p^2}}$. When effect sizes other than *d* were reported, they were converted to *d*s (Lenhard & Lenhard, 2016). The effect sizes were coded so that a positive value indicates an assimilation effect (i.e., the affective feelings are congruent with the affective stimuli presented) and a negative value of *d* indicates a contrast effect.

Meta-Analytic Procedure

The effect sizes were estimated for each experiment. Given the limited number of available relevant studies, we focused on the comparison between exposure to positive vs. negative stimuli. First, we performed random-effect meta-analyses on all the relevant studies and then tested the moderator effect of the type of presentation (visible vs. masked). Then we investigated whether the effects were moderated by the type of stimuli (pictures, words, facial expressions).

A number of 22 published and unpublished studies met our criteria and were included in the meta-analysis. These studies were presented in 15 research reports and present 37 effect sizes, for a total number of 2159 participants[3]. Nine of the studies used common measures of mood (e.g., MAACL, BMIS, UWIST). In 5 studies, mood was measured with a single item. Another group of studies measured primarily the level of happiness and sadness as indices of mood. Finally, a last group of studies included measures of several emotional feelings (e.g., anger, fear, sadness). For this group of studies, the effects were calculated only on the levels of experienced happiness and sadness, as these dimensions are more prototypical of the valence dimension of mood and were thus comparable to studies including typical mood measures. For these studies, as well as for studies including several measures of mood,

[3] Included articles are preceded by "*" in the references list.

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separate effect sizes were computed for each measure, with correction for non-independent effects (e.g., Cheung, 2019). Eighteen effect sizes were obtained from visible presentation of affective stimuli and nineteen effect sizes were obtained for masked presentation. We present the characteristics of the studies included in our meta-analysis in Table 1.

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Table 1.

Data Gathered from Studies Included in the Meta-Analysis. (Note: blank indicates that the information was not provided in the article).

Study	N	Age	Number of Women	Year	Country	Presentation of stimuli	Type of stimuli	Self-report measures*
Baumgartner & Wirth, (2012)	87	17	54	2012	Germany	Visible	Word	10 Items selected from the PANAS and the M-DAS
Burger & Bless (2016) – Study 1	48	22	24	2016	Germany	Visible	Picture	Affective 9-point Scale (how did the task change your mood?)
Burger & Bless (2016) – Study 2	220	33	150	2016	Germany	Visible	Picture	Affective 9-point Scale (unpleasant to pleasant)
Chartrand, van Baaren, & Bargh (2006)	61			2006	United-States	Masked	Word	MAACL
Chatelain & Gendolla (2015)	54	28	36	2015	Switzerlan d	Masked	Face	Happiness and sadness 7-point scales
Framorando & Gendolla (2019a)	166	23	81	2019	Switzerlan d	Masked	Face	Happiness and sadness 7-point scales
Framorando & Gendolla (2019b)	114	23	87	2019	Switzerlan d	Masked	Face	Happiness and sadness 7-point scales
Gendolla & Silvestrini (2011) – Study 1	45	22	38	2011	Switzerlan d	Masked	Face	Affective 7-point scales (2 positive scales, 2 negative scales)

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Gendolla & Silvestrini (2011) – Study 2	42	21	35	2011	Switzerland	Masked	Face	Affective 7-point scales (2 positive scales, 2 negative scales)
Lasauskaite, Gendolla, & Silvestrini (2013)	55	21	55	2013	Switzerland	Masked	Face	Affective 7-point scales (2 positive scales, 2 negative scales)
Pillaud & Ric (2020) – Study 1	164	22	133	2020	France	Masked & Visible	Word	BMIS (with one score for the valence dimension)
Pillaud & Ric (2020) – Study 2	148	21	118	2020	France	Masked & Visible	Picture	BMIS (with one score for the valence dimension)
Pillaud & Ric (Unpublished)	218	21	160	2018	France	Masked	Word	BMIS (with one score for the valence dimension)
Ric (2004) – Study 1	73		73	2004	France	Masked	Word	Happiness and sadness 11-point scales
Ric (2004) – Study 2	70		69	2004	France	Visible	Word	Happiness and sadness 11-point scales
Ric, Leygue, & Adam (2004)	57		48	2004	France	Visible	Word	Happiness and sadness 9-point scales Mood 9-point scale
Ric, Leygue, & Adam (2004)	96		72	2004	France	Visible	Word	Happiness and sadness 9-point scales Mood 9-point scales

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Schüpbach, Gendolla, & Silvestrini (2014)	134	21	127	2014	Switzerland	Masked & Visible	Face	Affective 7-point scales (2 positive scales, 2 negative scales)
Silverstrini & Gendolla (2011a)	56	23	48	2011	Switzerland	Masked	Face	UWIST mood adjective checklist
Silverstrini & Gendolla (2011b)	65	23	66	2011	Switzerland	Masked	Face	UWIST mood adjective checklist
Silvia, Phillips, Baumgaertner, & Maschauer (2006) – Study 1	65		52	2006	United-States	Masked	Face	BMIS (with two scores for postivie and negative affect)
Silvia, Phillips, Baumgaertner, & Maschauer (2006) – Study 2	58		58	2006	United-States	Visible	Word	BMIS (with two scores for postivie and negative affect) Mood 11-point scale

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Results

All statistical analyzes were computed with RStudio (metafor, Viechtbauer, 2010, meta, Balduzzi et al., 2019, and metaviz, Kossmeier et al., 2019, packages). Moderations were estimated with the meta-regression method (e.g., Thompson & Higgins, 2002; van Houwelingen et al., 2002).

Positive vs Negative

Statistical power.

We performed a retrospective power analysis to estimate the confidence we could have in the case of a non-significant effect (Valentine et al., 2010). For the meta-analysis, regardless of the level of presentation, with k = 37 (here, k represents the number of effects included), and an average sample size of n = 90, the power to detect a small effect (ES = 0.2) for a random effect model was .98 to .99 (depending on high, $\tau^2 = 3$, to medium heterogeneity; $\tau^2 = 1$). For the studies using masked stimuli, with k = 19 and an average sample size of n = 85, the power to detect a small effect was between .81 and .98. For studies using visible priming, for k = 18 and n = 100, the power to detect a small effect was between .85 and .99.

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Analysis of heterogeneity.

The analysis on the total set of studies revealed significant heterogeneity, $Q(36) = 52.12$, $p = .04$. This heterogeneity was found for both studies including visible stimuli, $Q(17) = 34.27$, $p = .008$, and studies including masked stimuli, $Q(18) = 436.24$, $p < .001$.

Meta-regression and moderator.[4]

To determine potential publication bias, we performed Egger's regression analyses (Egger et al., 1997) widely used to examine small-study effects. These analyses were not significant and are presented in Supplemental Materials.[5] The meta-analysis revealed no main effect of stimulus valence, $d = 0.066$, CI [-0.05; 0.18], $z(36) = 1.15$, $p = .25$ (Figure 2).

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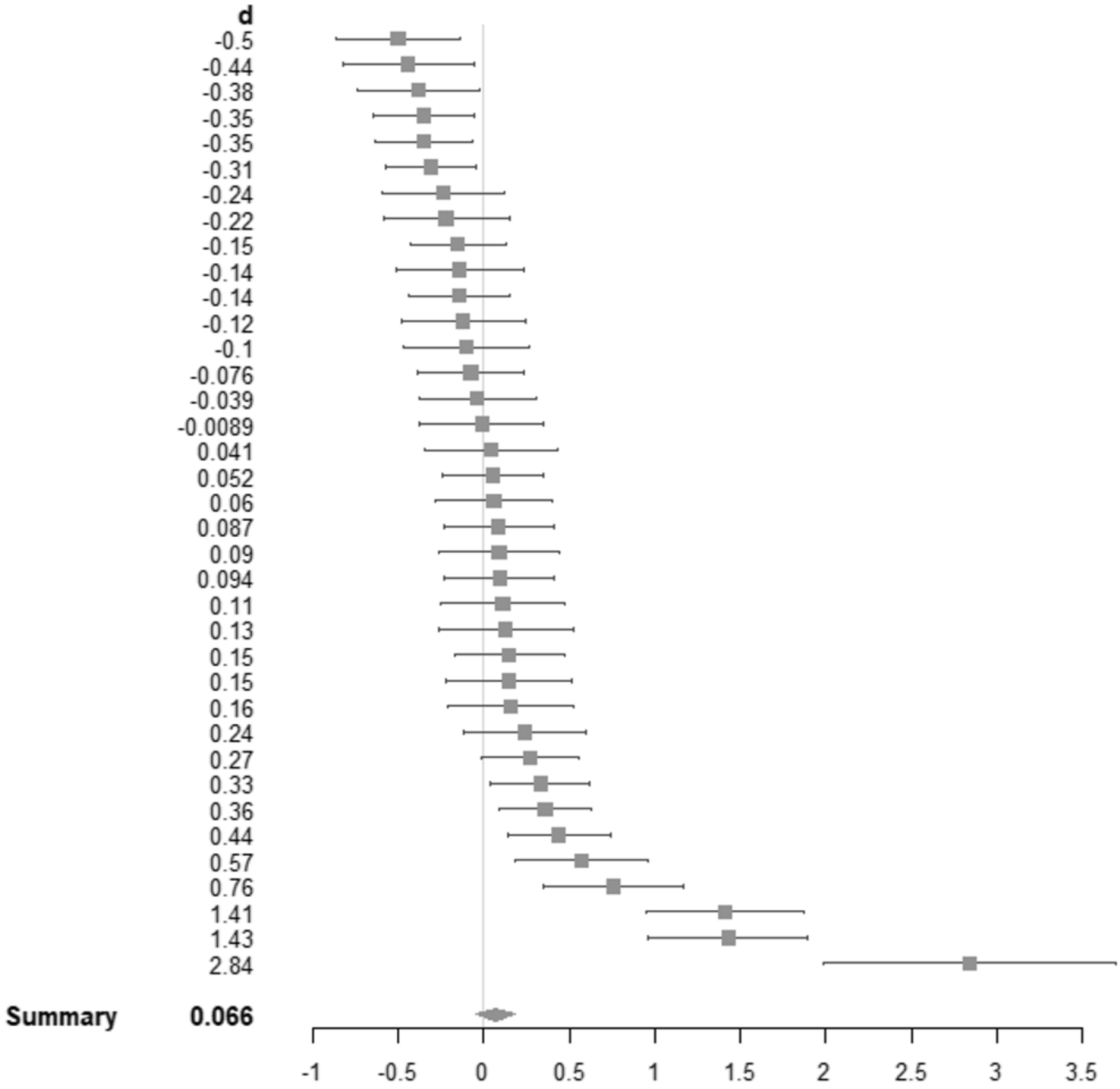
[4] The type of measures used can potentially play a role in the emergence of these effects. However, given the diversity of measures used in the studies included in this meta-analysis, we were unable to test this potential moderating role.

[5] In addition, funnel plots showing the effects as d_s versus their respective standard errors are presented in Supplemental Materials: Figure S1 for the meta-analysis on studies with visible stimuli and in Figure S2 for the meta-analysis on studies with masked stimuli.

Figure 2.

Forest Plot of the Effect Sizes Regardless of the Type of Presentation.



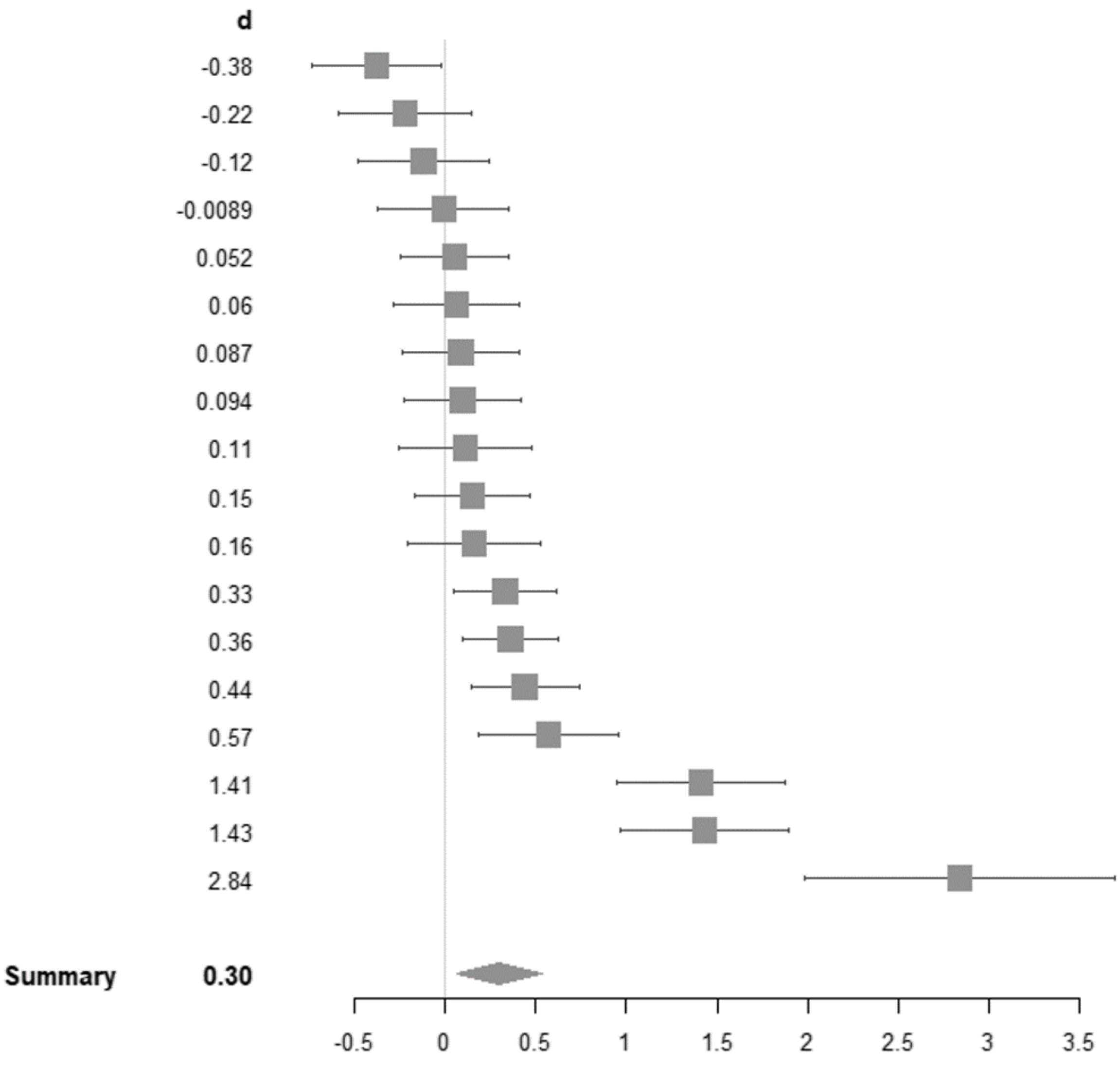
However, this effect was moderated by the type of presentation (visible vs. masked) of the stimuli, $Q_m(1) = 8.42$, $p = .004$. In the case of visible stimuli, the random-effect of valence was significant $d = 0.30$, CI [0.064; 0.54], $z(17) = 2.50$, $p = .01$.[6] On average, when

[6] A common method to detect outliers is to define a study as an outlier if the confidence interval of a study does not overlap with the confidence interval of the pooled effect (Viechtbauer & Cheung, 2010). One outlier was identified. When the outlier was excluded, the results remained unchanged.

stimuli were visible, participants reported a more positive mood after being exposed to positive than negative stimuli (Figure 3).

Figure 3.

Forest Plot of the Effect Sizes for Studies with Visible Presentation.

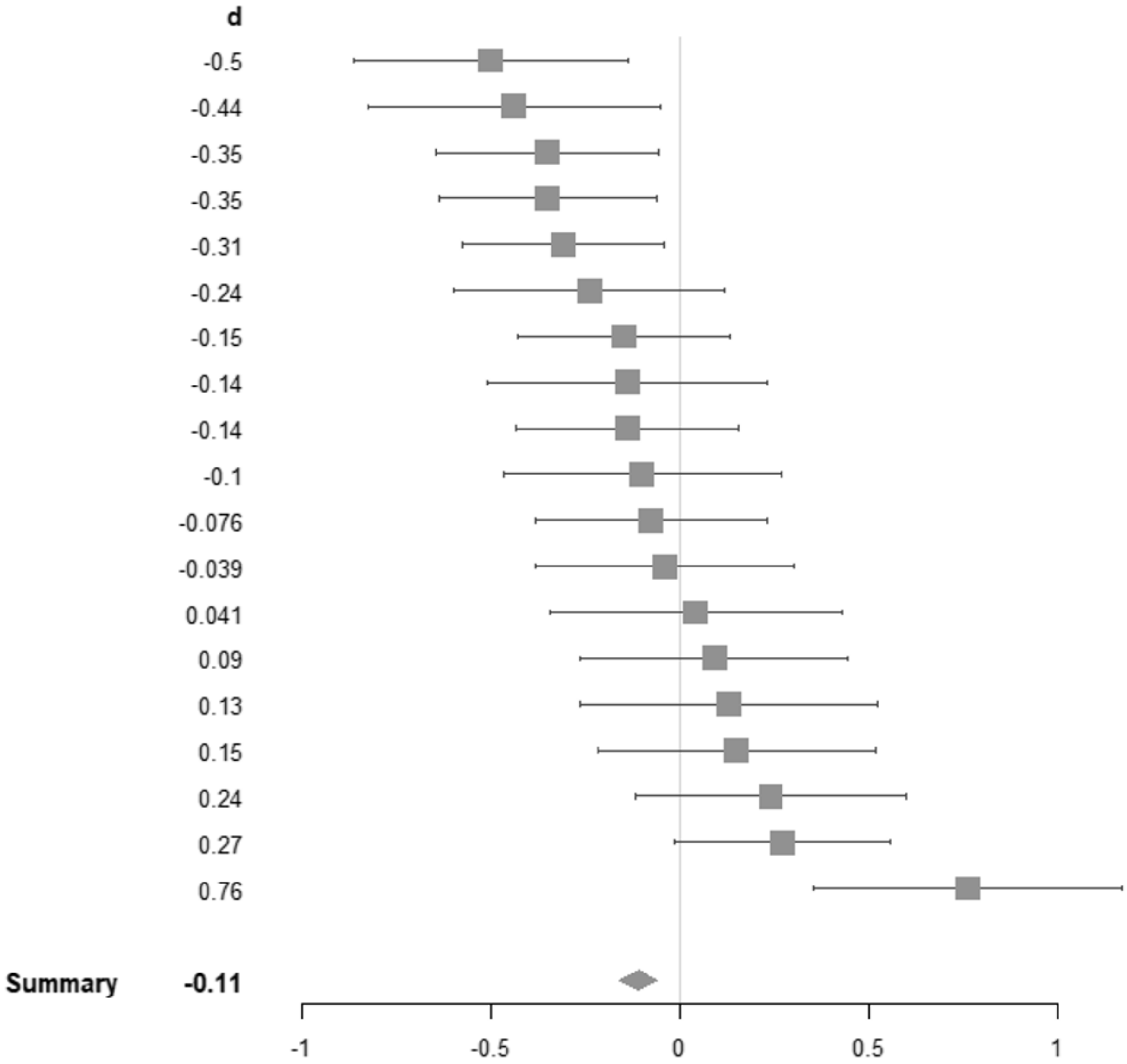


In the case of masked presentations of affective stimuli, the random-effect meta-analysis was significant, although of a small magnitude, d = -0.11, CI [-0.16; -0.061], z(18) =

-2.23, p = .03.[7] On average, when stimuli were masked, participants reported a more positive mood after being exposed to negative than positive stimuli (Figure 4).

Figure 4.

Forest Plot of the Effect Sizes for Studies with Masked Presentation.



[7] We identified one outlier. The results remained similar when this outlier was excluded.

We conducted analyses on the moderating role of stimulus type. Given the small number of studies per stimulus category (for both visible and masked stimuli), these results should be interpreted with caution. These analyses revealed a moderating role of the type of stimulus for both types of presentation. These analyses revealed that the type of stimulus moderated the effect of visible stimuli, $Q_m(3) = 8.87$, $p = .03$.[8] The effect was significant for pictures, $d = 0.52$, CI [0.14; 0.90], as well as for words, $d = 0.19$, CI [0.004; 0.38], with no difference between words and pictures, CI [-0.76; 0.09], $z(15) = -1.54$, $p = .13$. Participants exposed to positive pictures or words reported a more positive mood that participants exposed to negative stimuli. However, no effect emerged for facial expressions, $d = 0.05$, CI [-0.52; 0.63].

When stimuli were masked, the effect was also moderated by the type of stimuli, Q_m (3) = 6.29, p <.001[9]. The effect was significant for pictures, $d = -0.35$, CI [-0.52; -0.18], as well as for words, $d = -0.23$, CI [-0.37; -0.04], with no significant difference between these effects, CI [-0.22; 0.63], $z(16) = 0.96$, $p = .34$. Participants repeatedly exposed to negative masked pictures or words reported more positive feelings than participants exposed to positive pictures or words. Again, no effect emerged for facial expressions, $d = -0.03$, CI [-0.18; 0.13].

Discussion

The results of this meta-analysis indicate that repeated exposure to affective stimuli produces reliable changes in individuals' self-reported mood. However, the observed effects are clearly different depending on the visibility of the stimuli. In line with recent results

[8] We identified one outlier. The results remained similar when this outlier was excluded.
[9] We identified one outlier. The results remained similar when this outlier was excluded.

(Pillaud & Ric, 2020), exposure to visible affective stimuli leads to congruent affective feelings whereas a contrast effect is obtained when the affective stimuli are masked. These results appear to be at odds with the proposals by Chartrand and colleagues (2006) since the minimal perception of affective stimuli does not in itself produce congruent feelings. Awareness of the affective stimuli seems to be a necessary condition for the emergence of congruent affective feelings. Considering the different components of automaticity (Bargh, 1994; Melnikoff & Bargh, 2018; Moors & De Houwer, 2006), the results suggest that unintentional but not unconscious evaluation produces congruent affective feelings. Going one step further, it could be proposed that awareness of the affective stimuli could then lead to congruent mood through more elaborated higher-level processes. For instance, it is possible that affective feelings occur lately as a result of individuals' awareness of the affective tone of their environment. Repeated exposure to positive (negative) stimuli would lead participants to anticipate that the environment is safe (vs. problematic; e.g., Schwarz, 1990) and that the remaining stimuli would be positive (vs. negative), which would put them in a positive (negative) mood. Alternatively, evaluation processes could produce changes in bodily and mental components (i.e., action tendencies, physiological responses and motor expressions) that require consciousness to be interpreted as conscious feelings (Scherer & Moors, 2019).

If this is the case, then why do these stimuli lead to contrast effects when masked? Contrast effects have been regularly reported in the literature (e.g., Banse, 2001; Era et al., 2015; Glaser & Banaji, 1999; Hermans et al., 2003; Klauer et al., 2009; Murphy & Zajonc, 1993; Wentura, 1999; Winkielman & Gogolushko, 2018; see Bless & Burger, 2016). However, there is no consensual explanation for these effects. Moreover, some of these accounts also predict contrast effects for visible stimuli; other specifically target masked presentation conditions. Explanations of these effects indeed usually rely on the operation of correction processes (e.g., Glaser & Banaji, 1999; Winkileman & Gogolushko, 2018), which

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require both participants' awareness of the potential influence of the stimulus and the availability of processing resources to engage in correction processes (e.g., Herr et al., 1983; Strack et al., 1993). The perception of potential influence of the primes can be due to their extremity (Glaser & Banaji, 1999; Herr, 1986; Herr et al., 1983) or their salience (Strack et al., 1993). However, the present meta-analysis indicates that minimal exposure to affective stimuli produces contrast effects on affective feelings only when the primes are masked. Therefore, explanations in terms of correction processes appear unlikely to account for these results (e.g., Bless & Burger, 2016). Moreover, the few studies that have compared the effects of the same stimuli in visible vs. masked conditions have reported assimilation effects in the visible condition but contrast effects in the masked condition, suggesting that specific characteristics of the primes (e.g., extremity) are not responsible for the effect.

In contrast, the counter-regulation processes model (Rothermund, 2011; Rothermund et al., 2011; Schwager & Rothermund, 2013) provide a plausible account for these results. The counter-regulation principle proposes that individuals involved in goal pursuit process attempt to achieve a balanced affective-motivational state in order to avoid an escalation of the affective state, which would be highly dysfunctional in decision and behavior. This would be accomplished by focusing attention to information of opposite valence. For instance, focusing on positive information can prevent individuals from developing severe states of anxiety or depression. On the other hand, directing attention to negative stimuli could reduce the likelihood of euphoria and impulsive behaviors. For instance, Rothermund et al. (2011; see also Rothermund, 2003) observed that individuals were faster at detecting negative than positive stimuli in a search task when they just received positive feedback, whereas they were faster to detect positive than negative stimuli after positive feedback. By directly manipulating affective states, Schwager and Rothermund (2013) further showed that participants experiencing a positive (negative) affective state allocated more attention to

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valence incongruent than to valence congruent stimuli in a visual search (Exp. 1) and in an emotional Stroop task (Exp. 2). Based on this theoretical position, it can be proposed that in the absence of conscious perception of affective stimuli, individuals would (mis)interpret the information provided by these stimuli as an indication of their current affective-motivational state (e.g., Clore & Huntsinger, 2009), leading them to direct their attention on objects of opposite valence. This would lead individuals exposed to positive (negative) stimuli to focus their attention towards negative (positive) objects, ideas or memories, that would counterbalance the impact of the affective stimuli. Because these objects would receive more attention, they would then trigger incongruency effects on affective feelings (Pillaud & Ric, 2020).

Another explanation can be advanced. The presence of contrast effects in the masked studies indicate that affective information is extracted very early and probably unconsciously. The reason why this information, once activated, does not lead to congruent affective feelings could be due to the masking procedure, which is used in most studies testing the effects of unconscious evaluation. Such a procedure typically interrupts the processing of the current affective information. As a result, in masked conditions participants could react negatively to the interruption of exposure to a positive stimulus. In contrast, they would react positively when processing of negative stimuli is stopped by the mask. That is, automatic evaluation would actually have the potential to lead to congruent affective feelings as proposed by Chartrand and colleagues even when presented unconsciously, but that masking the primes would create specific effects by interrupting the processing of affective materials (Solomon & Corbit, 1974). Thus, it would be interesting to test whether such effects could be replicated either in studies in which affective primes would be visible and masked or in which stimuli would be made non-visible without a masking procedure (e.g., continuous flash suppression).

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We acknowledge that these two explanations for the contrast effects observed with masked stimuli remain speculative and thus require further direct empirical tests.

An interesting point is that the effects were different for pictures, words or emotional faces. The effects discussed in the preceding paragraphs were observed (and of the same magnitude) when pictures and words were used as stimuli. In contrast, no significant effect emerged when participants were exposed to emotional faces, presented either consciously (i.e., visible) or masked. This result is of importance for researchers that would explore the impact of affective stimuli on affective feelings as it seems that pictures and words would be more appropriate than facial expressions to produce these effects, as shown in previous studies (Gendolla & Silvestrini, 2011; Framorando & Gendolla, 2019a; Winkielman et al., 2005). Furthermore, these results provide no evidence that the effects of facial expressions stimuli observed on judgment (Murphy & Zajonc, 1993; Rotteveel et al., 2001), motivation (Framorando & Gendolla, 2019a, 2019b; Gendolla & Silvestrini, 2011), and behavior (Winkielman et al., 2005; Winkielman & Gogolushko, 2018) are mediated by conscious affective feelings. This absence of effect could be due to low statistical power, as the number of studies using emotional facial expressions as stimuli was limited. Two other options can be considered. A first possibility is that these effects are driven by processes that operate below the level of consciousness and guide more directly motivation and behavior. For instance, it could be proposed these effects are mediated by the activation of semantic content (e.g., Blaison et al., 2012; Rohr & Wentura, 2021), the activation of action tendencies of approach/avoidance (e.g., Ric, 2004; Rougier et al., 2018), or still by changes in psychophysiological activity (e.g., Gendolla & Silvestrini, 2011; Lasauskaite et al., 2013; Morris et al., 1999). Another interpretation is that emotional faces would convey nonconscious affect (Winkielman et al., 2005), but that this affect would be of different nature or intensity than the one conveyed by pictures or words and less likely to be detected by the

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measures used in the relevant studies (Winkielman & Gogolushko, 2018). Given the number of effects included in these analyses, this interpretation should be taken with caution. However, it would seem interesting to study empirically the differences between the types of stimuli on the emergence of an affective state.

It is important to note that in this meta-analysis, we were only interested in one of the affective dimensions of affective feelings, that is valence. We did not consider the other important dimension of affect, namely arousal (e.g., Russell, 1980; Russell & Barrett, 1999). Yet this dimension can lead to reportable subjective feelings (Russell et al., 1989). Arousal would provide information about the specificity (e.g., James, 1884; LeDoux, 1996; Damasio, 2003) and the intensity of what we are feeling (e.g., Valins, 1966). As such, arousal could be considered a potential moderator the effects described in this meta-analysis. Unfortunately, we are not aware of any studies that directly address the question of the impact of minimal exposure to affective stimuli on feelings of arousal. These fascinating questions remain in need of further exploration. This is our hope that this meta-analysis will stimulate empirical and theoretical works in this area of research to better understand the processes underlying the link between perception and feelings.

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Supplemental Materials

Egger's Regression Test. Egger's regression test was used to estimate potential publication biases (Egger, Smith, Schneider, & Minder, 1997) with the Begg method of bias estimation (Begg & Mazumdar, 1994). For the meta-analysis regardless the type of presentation (visible vs. masked), the Egger's regression test did not reveal any asymmetry, $z(36) = 1.69$, $p = .092$. Thus, we found no evidence of a publication bias. As a result, it was not necessary to apply a trim-and-fill algorithm (Duval & Tweedie, 2000).

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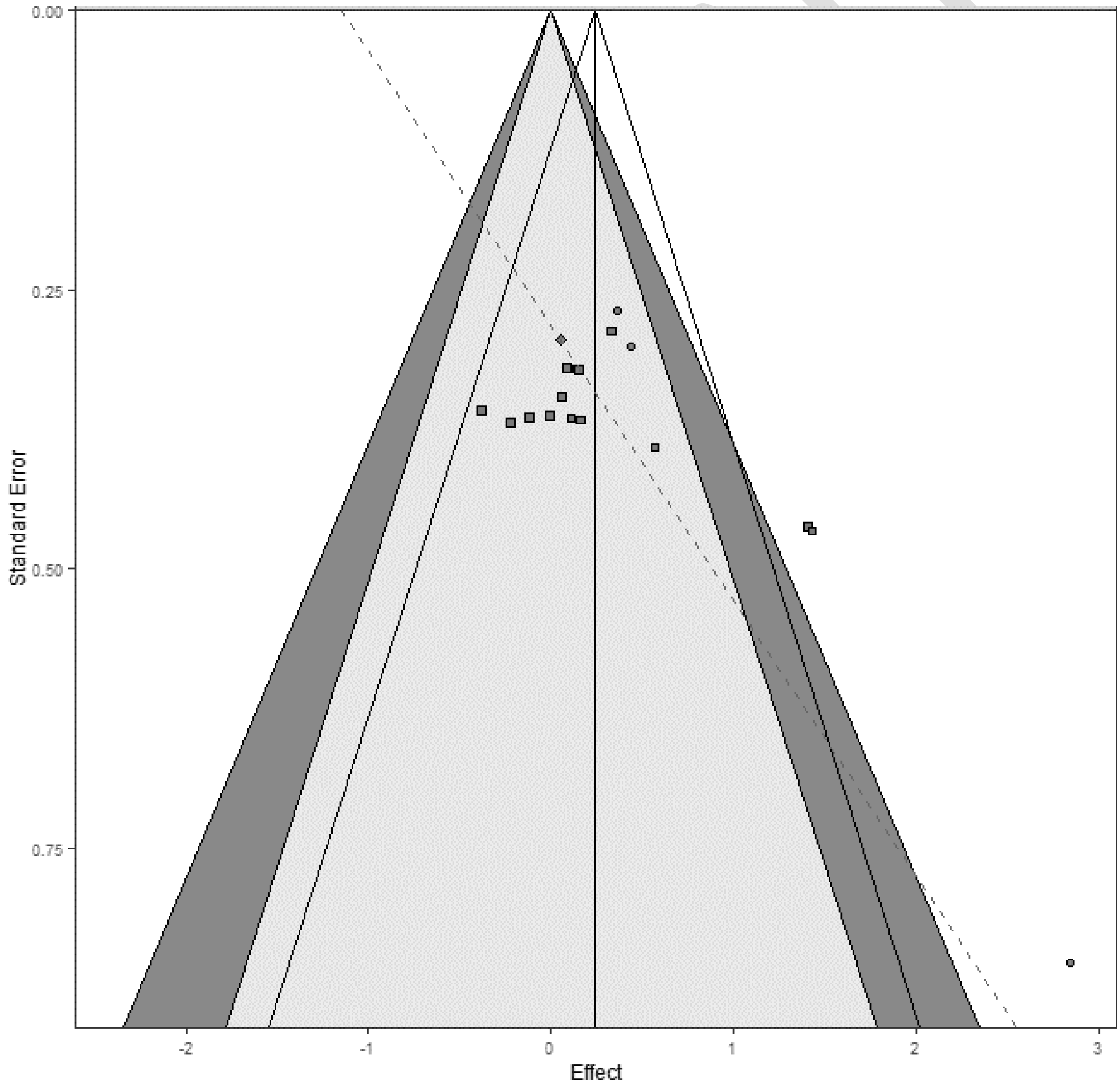
Funnel Plots for the Studies with a Visible Presentation. Figure S1 presents a funnel plot for the meta-analysis only on studies with a visible presentation of the stimuli, with the type of stimuli as moderator. The Egger's regression test did not reveal any asymmetry, $z(16) = 0.95$, $p = .34$. We included the Egger's regression test in the funnel plot (dotted line).

Figure S1.

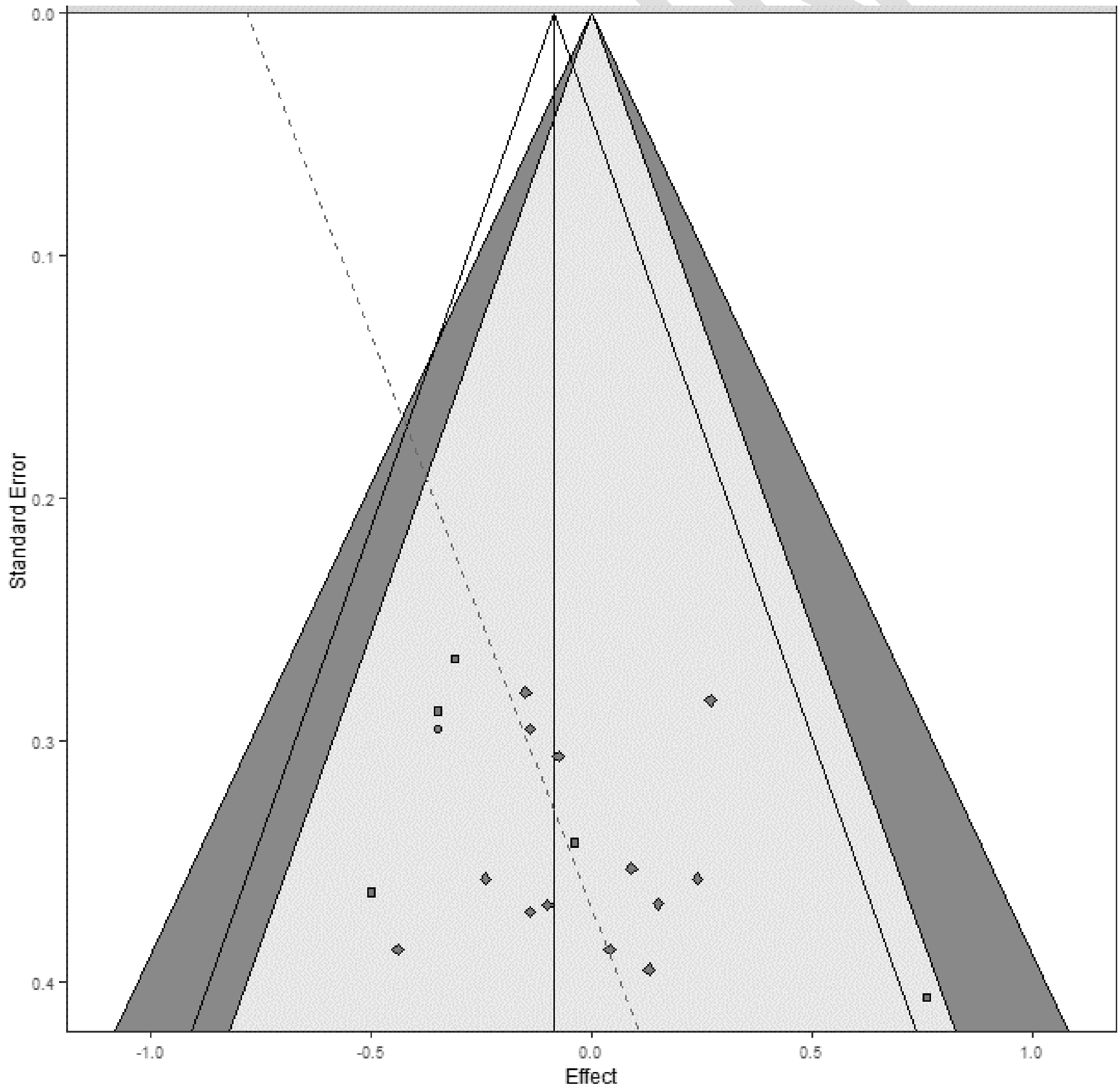
Funnel Plots for All Included Studies in the Meta-Analysis with a Visible Presentation of the Stimuli. The light grey and the dark grey funnels represent a 95% and 99% confidence level, respectively. The grey dots represent studies with pictures as stimuli. The grey squares represent studies with words as stimuli. The grey diamonds represent studies with faces as stimuli.



Funnel Plots for the Studies with a Masked Presentation. Figure S2 present a funnel plot for the meta-analysis only on studies with a masked presentation of the stimuli, with the type of stimuli as moderator. The Egger's regression test did not reveal any asymmetry, $z(17) = 1.61$, $p = .11$. We included the Egger's regression test in the funnel plot, shown with a dotted line.

Figure S2.

Funnel Plots for All Included Studies in the Meta-Analysis with a Masked Presentation of the Stimuli. The light grey and the dark grey funnels represent a 95% and 99% confidence level, respectively. The white dots represent studies with pictures as stimuli. The grey squares represent studies with words as stimuli. The black diamonds represent studies with faces as stimuli.



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