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# A Re-Examination of the Mere Exposure Effect: The Influence of Repeated Exposure on Recognition, Familiarity, and Liking

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To evaluate the veracity of models of the mere exposure effect and to understand the processes that moderate the effect, we conducted a meta-analysis of the influence of repeated exposure on liking, familiarity, recognition, among other evaluations. We estimated parameters from 268 curve estimates drawn from 81 articles and revealed that the mere exposure effect was characterized by a positive slope and negative quadratic effect consistent with an inverted-U shaped curve. In fact, such curves were associated with (a) all visual, but not auditory stimuli; (b) exposure durations shorter than 10 s and longer than 1 min; (c) both homogeneous and heterogeneous presentation types; and (d) ratings that were taken after all stimuli were presented. We conclude that existing models for the mere exposure effect do not adequately account for the findings, and we provide a framework to help guide future research.

*Keywords:* mere exposure, processing fluency, dual-coding model, familiarity, liking

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The *mere exposure effect* is the observation that liking for a stimulus increases on repeated exposure to that stimulus. The effect was first observed by Zajonc (1968), has since been documented by countless empirical studies, and has had its influence and pervasiveness trumpeted by numerous psychology textbooks (e.g., Kalat, 2010; Myers & Dewall, 2016; Schacter, Gilbert, Wegner, & Nock, 2015) and reviews of the attraction literature (e.g., Berscheid & Walster, 1978; Berscheid & Reis, 1998; Leary, 2009; Montoya & Horton, 2014). Among the vast scientific energy devoted to this effect, Bornstein's (1989) meta-analysis of 134 studies stands among the most influential. In that analysis, Bornstein identified (a) a reliable effect of exposure on liking; (b) eight moderators (e.g., exposure duration, stimulus type) that affected the magnitude of the effect; (c) an effect for boredom/satiation (i.e., an inverted-U shaped relation between exposure frequency and liking); and (d) that recognition was "not a prerequisite" for the mere exposure effect.

The goals of this article are to explore the nature of the mere exposure effect and to assess the different theoretical accounts for it. Our analyses capitalize on two decades of evidence and theoretical developments since Bornstein's (1989) review, and also on advanced meta-analytic methods that model curve estimates that allow for a more specific investigation of the relation between exposure frequency and the various psychological processes.

## Models of the Mere Exposure Effect

This review focuses on four models for the mere exposure effect: Zajonc's affective model, the original and modified two-factor models, and processing fluency. There are a multitude of theories for the mere exposure effect (e.g., arousal models, Crandall, 1970; prototypicality, Martindale, 1984), but we speak extensively to only models that have been articulated sufficiently well to allow for predictions to be made for a majority of the moderators of interest. In the discussion, we address recently described models that are not as developed in their predictions for the various moderators and questions.

### Zajonc's Affective Model

From Zajonc's (1968) perspective, people evolved to experience wariness and uncertainty when exposed to a novel stimulus, an instinctive fear response that subsides on repeated exposure and the absence of negative consequences. This reduction in the negative state after multiple exposures produces a relatively positive

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emotional response toward a specific stimulus. Taken one step further, Harrison (1968) proposed that repeated exposure produces response competition—the hypothesis that an aversive state is produced by the incompatibility between negative affect (as produced by the novelty of the stimulus) and positive affect (as generated by the lack of a negative consequence after exposure). In support of this affective approach, Harrison observed that increasing the number of exposures resulted in reduced negative affect and the concurrent rise in positive affect.

## Two-Factor Model

The original two-factor model proposed by Berlyne (1970) and Stang (1973) submitted that evaluation patterns associated with repeated exposure result from the combined effects of habituation and satiation. Berlyne's approach is consistent with Zajonc's (1968) approach to the extent that this model hypothesizes that individuals should fear the unknown (e.g., Berlyne, 1960, 1966). On repeated exposure, a linear increase in positive affect is produced by the greater familiarity and reduced uncertainty (called "stimulus habituation"). In contrast to Zajonc, this model also proposed a second, independent process that operates concurrently with habituation: stimulus satiation. Satiation increases the amount of boredom after repeated exposure to the same stimulus, producing a decline in positive affect. The consequence of these processes is an inverted-U shaped distribution for liking, in which the specific shape of the curve is determined by the relative strength of the two processes.

Whereas the original two-factor model focused on how consciously and deliberately processed stimuli were subject to the effects of stimulus habituation and satiation, Bornstein (1989) proposed that stimulus habituation and satiation have evolutionary roots and that such processes apply to both consciously and unconsciously processed stimuli.

## Processing Fluency

Processing fluency has its roots in dual-process models of memory and Zajonc's affective model. Jacoby and colleagues (Jacoby & Kelley, 1987; Jacoby, Toth, Lindsay, & Debner, 1992) proposed that previously perceived stimuli are encoded and processed more quickly and more easily than novel stimuli. In this way, repeated exposure increases the processing ease, speed, or "fluency" of presented stimuli (Whittlesea, Jacoby, & Girard, 1990).

There are three explanations for how liking can result from such fluency. First, some fluency researchers agree with Zajonc (1968) that there is a biological disposition to fear the unknown (e.g., Winkielman, Schwarz, Fazendeiro, & Reber, 2003), and submit that fluency indicates that a stimulus is not harmful. Second, some researchers posit that fluency produces a sense of familiarity and that this familiarity drives positive affect because it indicates that one has the ability to successfully process the stimulus (Carver & Scheier, 1990; Schwarz, 1990).

Third, and most commonly, some fluency researchers propose that liking for familiar stimuli results when the fluency is "misattributed" to liking, a misattribution that is most likely when liking is the most reasonable explanation for the processing ease (e.g., fluency/attribution model; Jacoby & Dallas, 1981; Jacoby & Whitehouse, 1989). Researchers have gone further to propose that the experience of fluency can be misattributed to both aesthetic and nonaesthetic evaluations, including assessments of truth (Begg, Anas, & Farinacci, 1992), understanding (Carroll & Masson, 1992), loudness (Jacoby, Allan, Collins, & Larwill, 1988), prototypicality (Winkielman, Halberstadt, Fazendeiro, & Catty, 2006), and familiarity (Whittlesea, 1993). As with Zajonc's approach, processing fluency researchers conclude that these fluency effects occur without conscious attention or deliberate cognitive processing (e.g., Reber & Schwarz, 1999; Seamon, Brody, & Kauff, 1983; Winkielman et al., 2003).

As can be noted from the above, there are multiple variations of the processing fluency approach. For example, for some researchers, the fluency cue itself is marked with positive affect (e.g., hedonic-fluency model; Winkielman & Cacioppo, 2001; Winkielman et al., 2003), but for other researchers, the fluency cue is affectively neutral and is associated with positive affect (e.g., liking) only because it is misattributed to a positive cause (fluency/attribution model, Bornstein & D'Agostino, 1994; Jacoby, Kelley, & Dywan, 1989; familiarity-attribution model, Bonanno & Stillings, 1986; Smith, 1998). For still other researchers, what is important is not an absolute level of fluency, but the relative fluency of a stimulus versus other stimuli (Dechêne, Stahl, Hansen, & Wänke, 2010; Whittlesea & Leboe, 2003). We primarily discuss predictions using the fluency-attribution permutation, as the predictions derived from this model are sufficiently fundamental that they are shared across most (if not all) of the other variants. However, there are exceptions to this rule; some derivations make different predictions for critical questions and/or descriptive moderators. We mention those predictions briefly in the sections below and elaborate on them in the discussion.

# Testing the Theories

We identified three questions and four descriptive moderators that allow for the assessment of the merit of the different theories and thus, a better understanding of the nature of the mere exposure effect. These questions and descriptive moderators are those for which the different theories either make different predictions or make similar predictions for different reasons. Table 1 summarizes the predictions proposed by each theoretical approach.

## Critical Questions

**What is the relation of liking to recognition and familiarity?** This question has a long history in the mere exposure literature (see Harrison, 1977; Kunst-Wilson & Zajonc, 1980; Matlin, 1971; Moreland & Zajonc, 1977; Wilson, 1979; Zajonc, 1980), and gained further traction when Bornstein's (1989) meta-analysis concluded that recognition was "not a prerequisite" for exposure effects to occur. For models of the mere exposure effect, the presumed answer to this question differentiates models that emphasize, versus minimize, the role of cognitive processes in the mere exposure effect. After all, if recognition is necessary for the mere exposure effect, cognitive processes are, in that context, the basis for affective ones.

***Zajonc's affective model.*** Zajonc and colleagues (Kunst-Wilson & Zajonc, 1980; Moreland & Zajonc, 1977; Zajonc, 1980) proposed that liking results without the influence of recognition.

Table 1
*Summary of Predictions*

| | Critical questions | | | Moderators | | | |
|---|---|---|---|---|---|---|---|
| | | | | Is an effect present? If so, what is it? | | | |
| Model | Relation between recognition and liking? | Inverted-U shaped curve for liking? | Difference between supraliminal and subliminal stimuli? | Type of stimulus | Delay | Participant age | Presentation type |
| Zajonc | Recognition and liking are independent; liking may affect recognition | Perhaps, but any effect is produced by extrastimulus phenomena | Intercept, slope: greater for subliminal<br>Quadratic: smaller for subliminal, positive coefficient for subliminal and supraliminal | Yes | — | — | Yes, homogeneous greater than heterogeneous |
| Processing fluency | Recognition reduces liking | Yes | Intercept, Slope: greater for subliminal<br>Quadratic: smaller for subliminal | Intercept: smaller for complex<br>Quadratic: greater for simple | Yes | Yes | Yes, heterogeneous greater than homogeneous |
| Original two-factor model | Recognition covaries with liking and increases liking | Yes | Intercept, slope: smaller for subliminal | Intercept, slope: smaller for complex<br>Quadratic: smaller for complex | Yes | Yes | Intercept, Slope: greater for homogeneous<br>Quadratic: greater for homogeneous |
| Modified two-factor model | Recognition hastens satiation, producing larger quadratic term | Yes | Intercept, Slope: greater for subliminal<br>Quadratic: smaller for subliminal | Yes | Yes | — | Yes, heterogeneous greater than homogeneous |

*Note.* Dash indicates that no clear prediction was made.

Zajonc proposed that "affective reactions to a stimulus may be acquired by virtue of experience with that stimulus even if not accompanied by such an elementary cold cognitive processes as conscious recognition" (Zajonc, 1980, p. 163). This independence is the consequence of the different processes by which liking versus recognition assessments are made. Specifically, recognition is based on specific details of a stimulus (called *discriminanda*), whereas affective responses are based in global stimulus features (*preferenda*). For Zajonc, preferenda, unlike discriminanda, can be drawn from very brief (i.e., subliminal) exposures and are sufficient to generate affective evaluations, whereas recognition (i.e., cognitive) judgments cannot. Recognition of discriminanda can only be increased via repeated supraliminal exposures. Moreland and Zajonc (1977) even went so far as to propose that "changes in affect may well mediate the observed relationship between stimulus exposure and recognition" (p. 199). In other words, Zajonc's approach posits that affect (liking) is independent of, and may precede and lead to, cognition (recognition).

***Two-factor model.*** The original approach proposed a strong link between recognition and liking during both the habituation and satiation phases. For the habituation phase, the amount of conscious recognition reduces uncertainty and leads to more positive affect (i.e., liking), particularly at small numbers of exposures (Stang, 1973). With a larger number of exposures, however, recognition facilitates the experience of satiation, which begins to outstrip the influence of habituation, such that liking declines as boredom increases even as recognition remains high. This divergence of recognition and liking arises because the stable and strong recognition motivates people to explore novel stimuli and avoid well-learned stimuli (Stang, 1975).

The modified two-factor model proposed that conscious recognition is unnecessary to produce liking and that the presence of recognition acts only to reduce liking via hastening the effects of satiation (Ye & van Raaij, 1997).

***Processing fluency.*** Processing fluency researchers propose that repeated exposure to a stimulus has different effects on recognition and on liking, primarily because of the link between recognition and liking. To begin, dual process models of recognition (e.g., Jacoby & Dallas, 1981; Mandler, 1980; for a review, see Yonelinas, 2002) make the distinction between familiarity and recollection. Familiarity is considered an unconscious, automatic process that reflects the strength of the memory, whereas recollection is considered a conscious, controlled process that involves the retrieval of missing information (Bacon, 1979; Jacoby, 1991; Mandler, 1979, 1980; Yonelinas, 1994, 1997). Research supports this distinction by noting that familiarity can be manipulated independently of recollection and vice versa (e.g., Hansen & Wänke, 2009; for a review, see Ochsner, Chiu, & Schacter, 1994; Squire, 1992).

For this approach, familiarity should have a *positive* influence on liking (Drogosz & Nowak, 2006; Winkielman, Schwarz, & Nowak, 2002). Past exposure results in stronger memories and greater familiarity, stimuli associated with strong memories and familiarity are associated with more fluency, and fluency results in more liking. However, recognition should have a *negative* influence on liking. If/when individuals become consciously aware of the source of the positive affect (which can occur with conscious recognition of a stimulus), it undermines the affect associated with the fluency, resulting in reductions in liking for the stimulus.

Like the two-factor model, fluency researchers posit that the relation between recognition and liking depends on the duration and number of exposures to a stimulus. When stimuli are presented a relatively small number of times (e.g., fewer than five exposures) or for a short duration (e.g., subliminal exposure), recognition and liking are related positively because in such situations, conscious recognition remains low. Alternatively, for stimuli that are presented more frequently or for longer duration (so that people become aware of source of fluency), recognition and liking are inversely related.

**Is there an inverted-U shaped relation between exposure and affect?** This question can also be stated as: "Does liking for a stimulus decrease after a certain number of exposures?" Bornstein (1989) and Harrison (1977) concluded that there was an inverted-U shaped relation for the mere exposure effect. Each model proposes such an inverted-U shaped relation may occur, but each approach has a different perspective on what produces it.

***Zajonc's affective model.*** Zajonc (1968) originally proposed a "monotonic" positive relation, rather than a curvilinear one, between exposure frequency and positive affect (also described as a "positive log function" by Zajonc, Shaver, Tavris, & Van Kreveld, 1972). Later research led Zajonc and colleagues to more specifically propose that a reduction in positive affect may result under certain circumstances, however, they concluded that any reduction in affect would not result from the "intrinsic consequence of repeated stimulus" (Crandall, Harrison, & Zajonc, 1974, p. 669 as cited by Zajonc, Crandall, Kail, & Swap, 1974) but from environmental/situational conditions that accompany the stimulus (e.g., reactance or frustration that may result when trying to learn novel stimuli while being asked to view "old" stimuli instead, Zajonc et al., 1972).

***Two-factor model.*** A fundamental component of the two-factor model is stimulus satiation, which posits that boredom inevitably follows from repeated exposures. The combination of stimulus habituation and satiation is hypothesized to produce an inverted-U shaped distribution. Bornstein's (1989) model agreed with this notion and provided an evolutionary basis for it, by hypothesizing that if a stimulus is repeatedly unpaired with reinforcement, the individual becomes bored with the stimulus and reorients to other stimuli associated with reinforcement.

***Processing fluency.*** Processing fluency, like the two-factor model, predicts an inverted-U shaped relation, but proposes that exposure not only increases fluency, but also increases recognition. At few exposures, or when recognition of the stimulus is relatively unstable, fluency is attributed to liking for the stimulus, and thus, exposure frequency is positively related to liking. With more exposure, and/or as recognition increases, the greater fluency is attributed to those repeated exposures, rather than to liking for the stimulus, which leads to a reduction in liking (Alter & Oppenheimer, 2009; Bornstein & D'Agostino, 1992, 1994).

***Are exposure effects different for subliminal versus supraliminal exposure?*** This question involves whether conscious processes are necessary for, promote, or inhibit the mere exposure effect. Each of the models that address this question proposes a more potent exposure effect for subliminal exposure than for supraliminal exposure, but they provide different theoretical explanations for the prediction.

***Zajonc's approach.*** Zajonc and colleagues (Kunst-Wilson & Zajonc, 1980; Moreland & Zajonc, 1982; Zajonc, 1980; for a discussion, see Moreland & Topolinski, 2010) proposed that supraliminally exposed stimuli, relative to subliminally exposed stimuli, are associated with activated cognitive processing that "dilute" the influence of affective processes, resulting in greater effects for subliminal than supraliminal presentations.

***Two-factor model.*** The original two-factor model made no specific mention of the potential importance of subliminal versus supraliminal duration exposures. The modified two-factor model, however, has generated two explanations: First, researchers (e.g., Bornstein, 1989; Ye & van Raaij, 1997) have invoked Kihlstrom's (1987) "conscious countercontrol" process (i.e., affective processes are inhibited by cognitive processes associated with conscious recognition), to submit that conscious recognition of a stimulus "counteracts" the change that results from unconscious affective processing. Second, Lee (2001) suggested that liking is reduced by tedium, but that subliminally presented stimuli are less affected by tedium, which then produces a larger mere exposure effect for such exposure durations (also see Nordhielm, 2002).

***Processing fluency.*** Fluency operates to generate liking when individuals are able to misattribute the experience of fluency to liking. To the extent that people believe their experience has been affected by the repeated exposure, they "discount" their experience and search for (potentially extrastimulus) reasons for their experience (for a discussion, see Westerman, Lanska, & Olds, 2015).

More recent research, however, has proposed an alternative explanation for the impact of subliminal/supraliminal exposure durations by incorporating the influence of habituation (e.g., Leventhal, Martin, Seals, Tapia, & Rehm, 2007). As is discussed later, the "habituation" as proposed by processing fluency researchers is fundamentally different from the "stimulus habituation" proposed by the two-factor model. For fluency researchers (and for many neuropsychologists studying memory; e.g., Henson & Rugg, 2003), habituation refers to the reduced neurological response (i.e., reduced neuronal firing) to a familiar stimulus (e.g., Tulving, 2002). From this perspective, simply processing stimuli generates habituation. Supraliminal presentations, but less so for subliminal presentations, generate habituation of the presented stimulus, which results in reduced liking for those repeatedly viewed stimuli.

**Descriptive moderators of the mere exposure effect.** Based on past meta-analyses and reviews of the mere exposure effect, we expected several variables to moderate the magnitude and pattern of the mere exposure effect. The variables include type of stimulus, the length of time that elapsed between exposure and testing (delay), homogeneous versus heterogeneous stimulus presentation type, and age of the participant. It is possible, of course, to generate an unending list of moderators (e.g., participant sex), but such moderators (a) lack theoretical development and testing across theories, and/or (b) lack adequate data across a sufficient number of studies to test predictions. As a result, we discuss competing theoretical explanations for the four moderators that (a) were discussed in past reviews of the mere exposure effect, (b) have been modeled by the various theoretical approaches, and (c) have sufficient empirical data available for analysis.

***Stimulus type.*** Syntheses of the mere exposure effect have each concluded that the type of stimulus moderates the effect. For example, Bornstein (1989) found that the magnitude of the mere exposure effect was consistent across an array of auditory and visual stimuli, with the exception being paintings/drawings/matrices, and Harrison (1977) concluded that simple, compared with complex, stimuli produce a more rapid asymptote. Below, we discuss how the different theoretical approaches address the different stimulus types, principle among these types of stimuli are the simple versus complex category.

***Zajonc's affective model.*** Zajonc (1980) proposed that stimuli sorted via preferenda (vs. discriminanda) should be associated with a greater exposure effect. Those preferenda-processed stimuli, which include stimuli that lack meaning (e.g., some pictures, meaningless words, abstract images) should result in more liking as a function of repeated exposure compared to stimuli that were evaluated via discriminanda (e.g., meaningful words).

***Two-factor model.*** Both the original and modified two-factor models proposed that the strength of the mere exposure effect for complexity was tied to the amount of learning needed to encode a stimulus. As abstract and/or complex stimuli are not as easily encoded as simple stimuli are, learning and uncertainty reduction are slower to develop, and thus, the development of liking for complex stimuli requires a larger number of exposures than is required for simple stimuli. However, simple stimuli are also more prone to boredom (i.e., "satiation") than are complex stimuli, which should produce a reduction in liking after a smaller number of exposures (Berlyne, 1970; Kail & Freeman, 1973). As such, the two-factor model proposes that the inverted-U relation between exposure and liking should occur at a smaller number of exposures for simple, as compared with complex, stimuli.

***Processing fluency.*** The processing fluency perspective aligns with the two-factor model to predict an inverted-U shaped relation between exposure and liking for both simple and complex stimuli. From this perspective, the impact of stimulus type is dependent on the ease with which stimuli are recognized and how one attributes the fluency that is generated by repeated exposure. Simple and meaningful stimuli are, by definition, processed with more fluency than are complex or meaningless stimuli, and thus the processing of simple stimuli stands to benefit less from repeated exposure than does the processing of more complex stimuli. As such, though a small number of repeated exposure may increase fluency for simple and meaningful stimuli, a peak fluency is reached quickly, and once conscious recognition is present, any fluency due to exposure is attributed to such repeated exposure, thus reducing liking (Winkielman et al., 2003). For complex stimuli, the source of fluency will be less obvious at small numbers of exposures, which allows for the attribution to liking for the stimulus. As such, the positive and linear effect of exposure should persist somewhat longer (in terms of number of exposures), with the downturn in liking occurring at a relatively large number of exposures (Reber, Schwarz, & Winkielman, 2004).

***Delay.*** Reviews of the mere exposure effect have observed that providing more time between the initial exposure and testing phase increased the potency of the mere exposure effect (Bornstein, 1989; Harrison, 1977). Zajonc's theory and the modified two-factor model make no specific prediction regarding the impact of a delay on the mere exposure effect.

***Two-factor model.*** The two-factor model posits that when there is no delay between exposure and assessment, the mere exposure effect resembles an inverted-U shaped distribution, with stimulus satiation causing the degradation in liking. However, with a delay, satiation of the stimuli dissipates, leaving only a monotonic increase in liking. This is particularly likely under conditions in which participants have not forgotten the original stimuli (e.g., with a short delay).

***Processing fluency.*** The processing fluency approach hypothesizes that a delay does not reduce the size of the mere exposure effect. Seamon, Brody, and Kauff (1983) proposed that a foundation of the fluency perspective is that stimuli remain in memory for years. Because memories remain for an indeterminately long time, they can continue to affect evaluations of stimuli. Consistent with this reasoning, Dechêne, Stahl, Hansen, and Wanke's (2010) meta-analysis of the impact of repeated exposure on assessments of truth (called the *truth effect*) revealed no effect for delay in studies that used typical mere exposure methods.

**Presentation type.** During the exposure phase, stimuli are presented either homogeneously (same stimulus repeated multiple times before the next stimulus is presented) or heterogeneously (stimuli are intermixed with one another as they are presented). Reviews by Bornstein (1989), Harrison (1977), and Stang (1974) all concluded that a homogeneous presentation is associated with smaller effects compared to a heterogeneous presentation.

***Zajonc's approach.*** The response-competition hypothesis proposes that the negative affect induced by a stimulus should be particularly pronounced by a homogeneous presentation (Harrison & Crandall, 1972). As such, homogeneous presentations result in a larger exposure effect than heterogeneous presentations.

***Two-factor model.*** The two-factor model's indictment of boredom as an obstacle to liking indicates that the mere exposure effect should be greater for heterogeneous presentations. Berlyne (1970) proposed that homogeneous exposure "strengthens" the satiation response, which reduces the overall effect (also see Bornstein, 1989; Harrison & Crandall, 1972). Alternatively, heterogeneous presentations lessen the impact of tedium and thus facilitate the relative effects of stimulus habituation. Two predictions can then be made: First, homogeneous presentations are associated with a smaller exposure effect and a lower average rating. Second, homogeneous presentations reach an asymptote at a comparatively smaller number of exposures, as boredom is greater and should more quickly come to dominate the favorable impact of habituation.

***Processing fluency.*** For the fluency approach, there is a larger effect for repeated exposure for heterogeneous presentations because of the link between recognition and liking. Specifically, heterogeneous presentations reduce people's awareness that the same stimuli are being repeated. Such reduced awareness delays the point at which people begin to attribute fluency to repeated exposure rather than to liking. Thus, the favorable influence of repeated exposure on liking persists to a higher numbers of exposures, which translates into a larger effect when stimuli are presented heterogeneously rather than homogeneously.

***Participant age.*** Reviews and studies have provided inconsistent conclusions regarding whether participant's age affects the magnitude of the mere exposure effect. Whereas a review (Bornstein, 1989) and individual studies concluded that the effect is smaller in children (e.g., Fantz, 1964; Hunter, Ames, & Koopman, 1983; Nachman, Stern, & Best, 1986), Harrison (1977) concluded that age did not affect the operation of the mere exposure effect. Only the modified two-stage model and processing fluency provide a prediction for this moderator.

***Two-factor model.*** The modified model predicts an exposure effect for adults and not for children by citing evolutionary advantages for adults to prefer safe, familiar stimuli but for children to prefer novelty, given that they remain under the watchful eye of caregivers who can set safe limits on such novelty seeking (Bornstein, 1989). By this reasoning, children experience less potently the link between novelty and negative affect. Given that novelty is not particularly aversive for children, repeated exposure does little to change children's affective responses.

***Processing fluency.*** The processing fluency approach posits that humans are born with the ability to easily process "specific classes" of stimuli (which includes different musical tones, human faces). Most other stimuli, however, are particularly difficult for infants/children to process easily. Children have fewer mental structures for understanding their world, reducing the likelihood of experiencing fluency. However, as people age and mature, they experience new things and learn to more rapidly experience fluency after repeated exposure. Thus, processing fluency proposes that exposure effects should have a greater impact on adults versus infants/children (Reber, Schwarz, & Winkielman, 2004).

***Other descriptive moderators.*** We also investigated a number of other moderators, including gender, interstimulus interval (ISI), and total experiment time. The moderating impact of ISI and total experiment time, for instance, is critical for assessing the merit of the original and modified two-stage models, which both propose an influence of boredom and/or fatigue on the operation of the exposure effect. For many of these potential moderators, no a priori theoretical expectations are available, but yet their patterns potentially provide insight into the operation of the mere exposure effect.

## Summary and Current Analyses

Models for the mere exposure effect diverge somewhat in their predictions regarding the critical questions and the moderating effects of stimulus type, delay, age, and presentation type. In general, Zajonc's model stands apart from the other theories in its expectations of a monotonic increase between repeated exposure and liking (rather than the inverted-U shaped relation presumed by the other models), and regarding several of the descriptive moderators (e.g., stimulus type, presentation type). For their part, the two-stage and processing fluency models differ not in the predictions they make (for the most part), but in the mechanisms they presume account for various effects. Indeed, the former model places extensive weight on the tendency toward satiation in the face of repeated exposures. Alternatively, fluency models emphasize the manner in which individuals experience and then make sense of fluency. The current work differentiated among these theoretical approaches using meta-analytic methods that allowed for investigation of growth curves for different outcome measures (e.g., liking, familiarity, recognition) as a function of exposure frequency.

## Method

### Sample of Studies

**Literature search.** We began by conducting an electronic literature search using the PsycINFO and Dissertation Abstracts International databases. The search extended to January, 2016. Our keywords matched and expanded on those used by Bornstein (1989), and included searches for exposure, mere exposure, familiarity, recognition, frequency, wear-in/out, priming, and perceptual priming. We reduced the impact of file drawer effects (i.e., the likelihood of articles reporting nonsignificant effects going unpublished; Rosenthal, 1979) by (a) searching PsycINFO and ERIC index dissertations for unpublished works, (b) sending requests for relevant studies to Internet discussion forums used by cognitive and social psychologists, and (c) contacting researchers who had published research repeatedly on the topic to request copies of any relevant unpublished or *in press* articles.

**Inclusion criteria.** Following the standards forwarded by Bornstein (1989), all studies: (a) focused on human participants, and (b) investigated the unreinforced presentation of neutrally valenced auditory or visual stimuli. The latter constraint was based on Bornstein's argument that olfactory/gustatory stimuli are inherently reinforcing and thus, are not true mere exposure studies.

We added two additional, more stringent, inclusion criteria: First, the study had to include three or more exposure frequencies. This criterion was added because an analytic strategy of modeling growth curves requires at least three data points. Second, the outcome measure had to be continuous (vs. so-called "forced choice" measures in which participants are asked to select the one [of the two presented] stimuli they preferred) with identified upper and lower endpoints (e.g., 1 = *not like at all* to 7 = *like a lot* was included, but time or distance were not).

After eliminating those studies that did not experimentally investigate the impact of repeated exposure, 347 articles remained. From this subtotal, the two most common reasons for exclusion were the use of: (a) a dichotomous outcome variable (i.e., forced choice), which resulted in the removal of 70 articles (20%); and (b) fewer than three exposure frequencies to manipulate exposure frequency (65 articles; 18%). These two exclusion criteria were invoked more commonly for articles published after Bornstein's (1989) meta-analysis. A chi-square test for the reason for exclusion relative to publication year revealed that articles were more likely to be excluded due to employing fewer than three exposure frequencies (relative to any other exclusionary reason) if the article was published after, versus before Bornstein's article's impact (specifically, 1993; Cho, Tse, & Neely, 2012), $\chi^2(1) = 9.10$, $p < .05$.

**Coding.** We used Bornstein's (1989) meta-analysis and Stang's (1974) synthesis as the foundation for the coding scheme. For several variables, we used the categories as defined by Bornstein: type of outcome measure, stimulus type, delay between stimulus exposure and rating, presentation type (i.e., homogeneous vs. heterogeneous), and stimulus exposure duration. Codes applied to individual studies can be found in the Appendix.

With respect to delay, we faced the same problems as did Stang (1974) and Bornstein (1989), with (a) some delays between exposure and test being brief (e.g., 5 min); and (b) some researchers not specifying precisely the exact time delay (but reporting the tasks participants completed. In such cases, we, as did Stang [1974], estimated the approximate delay time). Following Bornstein (1989), we coded delay by placing effects into one of three categories: immediate assessment after each stimulus exposure (e.g., stimulus assessments were interspersed within the exposure phase), assessment occurred immediately after the final presentation of the exposure phase (i.e., no delay between exposure phase and test phase), or the assessment followed the exposure phase and a temporal delay (i.e., any estimable delay between the exposure and test phase).

For age, the "children" articles included participants as young as fourth graders (e.g., Heingartner & Hall, 1974) and as old as high school students (e.g., Kruglanski, Freund, & Bar-Tal, 1996).

In addition to Bornstein's (1989) codings, we also included two additional experiment-level moderators: interstimulus interval and the total experiment time. Interstimulus interval refers to the time between the end of the presentation of one stimulus and the beginning of the presentation of the next stimulus. We computed the total experiment time by multiplying the total number of exposures by the duration of each exposure.

We coded for a number of outcome measurement types, including prototypicality, truth, goodness, correctness, liking, and pleasantness, but also familiarity and recognition. These last two assessments require additional discussion. To measure familiarity, we included studies that used a continuous measure of subjective familiarity (e.g., "Rate the degree to which the stimulus is familiar on a 1 = *unfamiliar* to 7 = *familiar* scale"). With respect to recognition, although it has traditionally been treated as a dichotomous measure (Yonelinas, 1994), recent research (Ingram, Mickes, & Wixted, 2012; Parks, Murray, Elfman, & Yonelinas, 2011; Rugg & Curran, 2007; Wixted, 2007; Woodruff, Hayama, & Rugg, 2006) and a recent review (Pazzaglia, Dube, & Rotello, 2013) conclude that recognition, like familiarity, is best considered as a continuous assessment. Given this, we included studies that included a continuous assessment of recognition in our analyses (e.g., 1 = *not at all recognize* to 7 = *very much recognize* scale).

We also assessed the basic demographic and methodological characteristics of the studies. We coded for author(s), university affiliation, source (journal, edited volume, thesis or dissertation, and unpublished manuscript), year of publication, recruitment method (participant pool, monetary incentive, or volunteer), and participant's sex.

***Coder reliability.*** Two undergraduate students coded the articles after being trained by the first author. We assessed reliability by comparing the coders' rating with each other and with those of the first author. Reliability was examined using Krippendorff's alpha (K alpha, Hayes & Krippendorff, 2007; Krippendorff, 2011). Mean K alphas between the first author and the raters across the various codes was sufficient, .82 ($SD = 0.04$, min = .73). Mean indices between the two raters was also sufficient, .79 ($SD = 0.03$, min = .70). When a disagreement was present, the issue was discussed between the raters and then with the first author until agreement was reached. The consensus code was used in the analyses.

***Missing values.*** A small number of studies did not indicate a codable value for one or more of the moderators, most commonly, for exposure duration or interstimulus interval. Those data values were coded as "missing." In the final database, the total number of data missing was small (3.2%). Following the recommendations of Pigott (2009), we employed listwise deletion for those specific moderator analyses.

## Meta-Analytic Procedure

The most influential summary of the mere exposure effect was presented by Bornstein (1989). However, the meta-analytic methods available in 1989 did not allow for a statistical test of the curvilinear relation that was an important foundation for Bornstein's modified two-stage interpretation of the mere exposure effect. Indeed, that interpretation was based (a) on the correlation between liking and exposure frequency for studies that used different overall numbers of exposures and exposure durations, and (b) a descriptive comparison of the size of the correlation for studies that varied by number of maximum exposures and stimulus duration. Problems with this analytic approach may have led to a description of the mere exposure effect that does not accurately reflect its actual operation. After all, the use of a correlation (a) cannot represent curvilinear relations (Twomey & Kroll, 2008); (b) is not accurate for those studies with a small number of frequencies (Miller, 1994; Onwuegbuzie & Daniel, 2002); (c) incorrectly estimates the relation for distributions with more dramatic curvatures (Jones & Payne, 1997); and (d) is strongly affected by extreme exposure frequencies (e.g., studies that included exposure frequencies that spanned between zero and 500). Fortunately, meta-analytic methods for estimating directly such curvilinear relations are now available and are employed in this work.

The studies of the mere exposure effect are repeated-measures investigations in which some rating of liking, familiarity, or recognition is captured at each exposure. For the meta-analysis, we employed a strategy of estimating the growth curve for each investigation via a quadratic regression of the mean ratings on the number of exposures and number of exposures squared. Ratings were expressed as a percentage of the distance through the possible range of the rating scale to address between-study differences in the scale used. We corrected the covariance matrix of the sampling distribution of regression parameter estimates to express variability in the metric of raw data instead of means. We then employed a multivariate random-effects meta-analytic model to combine the parameters of the growth models.

Although the practice is not frequently observed in the social sciences because models are rarely equivalent across primary studies, it is possible to meta-analyze multiple regression models such as the quadratic growth models that are of interest in the current investigation. Here, the models *are* equivalent across studies because the interest is always in a quadratic curve relating a rating to the number of exposures. The procedure is similar to simpler meta-analyses, but whereas typical random-effects meta-analytic methods estimate a mean effect weighted by the inverse of the sampling variance plus a between-studies variance component, here we estimate a mean vector of regression coefficients, weighting by the inverse of the covariance matrix of the sampling distribution plus a variance component.

The absence of raw data from the primary studies poses a challenge. Typically, each study provides a mean rating at each exposure level. Whereas the parameter estimates of a quadratic regression involving these means are identical to what they would be if the analysis were conducted using raw data, obtaining information about sampling uncertainty (necessary for the weighted analysis) requires a somewhat convoluted process. The sums of squares in the regression involving the means differ from the raw-data sums of squares by a factor of $N$ (the sample size underlying the means). One can translate from the mean-regression information to the raw data information by the following algorithm (Vevea & Citkowicz, 2010):

1. Observe the model sum of squares for a regression that perfectly fits the means (i.e., a regression with the number of predictors equal to the number of means minus one);
2. Multiply that sum of squares by the sample size;
3. Calculate the error sum of squares from the sample size and the original ANOVA mean square from the primary study;
4. Calculate the raw data total sum of squares by adding the model and error sums of squares from Steps 1 and 3;
5. Estimate the quadratic regression using the means;
6. Multiply the model sum of squares from that regression by $N$;
7. The error sum of squares is the total sum of squares from Step 4 minus the model sum of squares from Step 6;
8. Use the error sum of squares from Step 7 to calculate the correct covariance matrix for the raw-data metric.

Once that covariance matrix is available, maximum likelihood estimates of the variance component and mean regression estimates may be calculated by optimizing the log-likelihood

$$LL(\beta, \tau^2) = \frac{1}{2}\sum_{i=1}^{K}\left[\log|\Sigma_i| + (T_i - \beta)'\Sigma_i^{-1}(T_i - \beta)\right],$$

where $\Sigma_i$ is the covariance matrix for study $i$ with variance component $\tau^2$ added to the upper left corner, $T_i$ is the vector of estimated regression coefficients from study $i$, and $\beta$ is the mean vector of regression coefficients to be estimated. Optimization is easily implemented using software such as R′s nlminb (R Core Team, 2013).

Maximum likelihood estimation provides a general framework for hypothesis testing by comparison of nested models. One model is said to be nested within another if the more complex model becomes the simpler model when a parameter or set of parameters is fixed or constrained. The likelihood-ratio chi-square statistics test the significance of the constrained parameter and is calculated by taking twice the difference between the log-likelihoods of the competing models. The degrees of freedom are equal to the number of fixed parameters. In the present analyses, we employed likelihood ratio tests to compare models with and without the quadratic regression term (to test the significance of the quadratic slope). We also compared models with a linear term and models with only an intercept (to test the significance of the linear slope). All of these likelihood-ratio chi-square tests have one degree of freedom.

In addition to likelihood-ratio chi-square tests on the growth parameters, we conducted moderator analyses in which separate growth-curve analyses were conducted for different classes of primary studies. These single-growth-curve analyses are formally nested within the separated-growth-curves analysis, so that moderation may be tested by likelihood-ratio chi-square with degrees of freedom equal to three (growth parameters and variance component) times the number of levels in the factor minus one. So, for example, tests for changes in the growth curve pattern for a three-level factor have $df = 6$.

**Sensitivity analyses.** One potential shortcoming in the methods employed here is that changes in the error structure in the primary studies related to the fact that they are repeated-measures investigations cannot be recovered from the between-subjects means. It is difficult to predict how inference would change if we could actually recover the true error structure. (Under varying circumstances, the change could either enhance or reduce power.) We address this problem through a sensitivity analysis in which all likelihood ratio tests are recalculated with tripled variances. In most cases, this has the effect of reducing the magnitude of the chi-square. Only a small number of the original conclusions about the form of growth (i.e., findings about the significance of linear and quadratic growth) changed under the sensitivity analysis. Almost all of those changes occurred in cases in which the actual magnitude of growth components was markedly small. Exceptions to this case are described in the Results section.

**Translating theoretical predictions for our analyses.** The four theoretical approaches generate different predictions for how the mere exposure effect operates relative to the different moderators. These models have discussed findings and predictions using an ANOVA-like approach, describing predictions and findings in terms of whether the average effect for one condition was "greater than" or "less than" another condition. A discussion is necessary to describe how predictions for the different theoretical approaches were "translated" to match the meta-analytic output from growth curves. Specifically, how does a predictor for one condition being "larger" than another condition translate to results that are in terms of an intercept, slope, and quadratic term?

An ANOVA-like conceptualization of a main effect maps most directly to the slope of the growth curves. Indeed, predictions derived from such conceptualizations indicate a larger slope, such that each change in the unit of the moderator (stimulus type, exposure duration, etc.) reflects a larger change in the outcome variable (e.g., liking, recognition). Alternatively, predictions for the quadratic term of growth curves do not flow as directly from an ANOVA conceptualization. The sign of the quadratic term refers to whether the curve opens up or down, and the magnitude of the term refers to the width of the parabola stretch, with larger terms indicating narrower (more extreme) curves. The intercept is the constant, in the context of this analysis, which indicates the "baseline" preference for a given stimulus (i.e., the rating of an object that has been viewed zero times). As such, the intercept is less informative and less translatable to an ANOVA-conceptualization than the slope and quadratic term.

We "translated" the predictions from the four theoretical models using two methods, and they are discussed in order of preference. First, when specific predictions regarding slope, intercept, or the quadratic coefficient were explicitly mentioned by past research, those were used. Second, in some cases, past research discussed only the "rise and fall" of an effect. In these instances, the slope (and a positive quadratic term, if identified), and peak exposure speak to the "ascent" phase of the mere exposure effect. Alternatively, the quadratic term and "peak at exposure" (when does the downturn happen and how big is it?) are critical to defining the "descent," if it occurs. Given this logic, we defined those effects associated with a nonsignificant slope or negative slope as effects inconsistent with predictions of the mere exposure effect. A review of the "translated" predictions from the original ANOVA predictions is summarized in Table 1.

# Results

## Sample and Overall Effect

The sample included 76 published articles, two dissertations, and three unpublished data sets. Two-hundred and sixty eight curve estimates were derived from 118 different studies from the 81 separate articles. Table 2 presents the number of studies that contributed information for each exposure frequency and the mean value for three key outcome variables (liking, familiarity, and recognition). The sample sizes ranged from 10 to 842 ($M = 71.27$, $SD = 86.32$), with the total sample including 8,410 participants. As a reminder, the data are in the form of the proportion of the distance through the possible range of the rating scale, such that 0 equals the lowest possible rating and 100 (or as presented in the figure, 1.0) equals the highest possible rating.

We began by estimating the average effect that included all effect sizes. This initial analysis reflects the impact of repeated exposure on judgment, quite generally, across judgment types, stimulus types, and methodological contexts, and so forth, variables we disaggregate in later analyses. The average effect for repeated exposure is represented by the quadratic equation, $y = .66285 + .00232x - .000018x^2$. The intercept indicates that the average rating at zero exposures was approximately two thirds of the range. A test of whether the slope was different from zero was significant, $\chi^2(1) = 1776.78$, $p < .001$, indicating a significant positive increase with repeated exposure. The slope coefficient and test revealed that the effect was statistically significant, but the amount of change as the number of exposures increased was not large. A test of the quadratic term was also significant, $\chi^2(1) = 794.80$, $p < .001$, indicating a negative deflection in the curve estimate. Investigation of the peak values derived from the quadratic term revealed that the maximum effect was reached at 0.73 (i.e., an index of the proportional distance through the range of possible scale values) and at 62.18 exposures (i.e., the downturn in the overall exposure effect resulted after the 62nd exposure).[1]

## What is the Relation of Liking to Recognition and Familiarity?

Because this question presupposes that the mere exposure effect is critical for understanding the role of affect versus cognition, only those studies that measured "affective" assessments were used (liking, pleasure; see Table 3 for the full list of measurement types). Specific to the mere exposure effect, theorists agree that affective assessments are different from cognitive assessments and should not be combined (e.g., Berlyne, 1974).

Including affective effects along with recognition and familiarity assessments resulted in an analysis with 182 effect sizes. We compared the liking evaluations ($k = 141$) to recognition ($k = 24$) to familiarity ($k = 17$). There was an effect for measurement type, $\chi^2(6) = 5693.42$, $p < .001$. The liking estimate revealed a positive slope and negative quadratic term, $y = .66051 + .00176x - .000024x^2$, with a significant slope and quadratic term, $\chi^2(1) = 383.28$, $p < .05$ and $\chi^2(1) = 206.11$, $p < .001$. The curve for recognition also indicated a positive slope and negative quadratic term, $y = .67219 + .01713x - .000226x^2$, both of which were significant, $\chi^2(1) = 2848.20$, $p < .001$ and $\chi^2(1) = 1663.72$, $p < .001$. The curve for familiarity also revealed a positive slope and negative quadratic term, $y = .46182 + .06724x - .00197x^2$, which were both significant, $\chi^2(1) = 2062.42$, $p < .001$ and $\chi^2(1) = 767.35$, $p < .001$. The results revealed that there was an initial sharp rise and fall for familiarity followed by a slower rise and fall for recognition and liking. Furthermore, due to the greater intercept and slope for recognition, recognition values exceeded liking values until the 76th exposure.

## Is There an Inverted-U Shaped Relation Between Exposure Frequency and Liking?

To address this question, we examined only those studies that assessed liking as an outcome measure. In this analysis, we were particularly interested in whether the sign of the quadratic term was negative versus either positive or not significant, as a negative sign would be consistent with an inverted-U shaped distribution. The average effect for liking effects is represented by the equation, $y = .66131 + .00191x - .000026x^2$. The slope was significant, $\chi^2(1) = 513.32$, $p < .001$, as was the quadratic term, $\chi^2(1) = 270.63$, $p < .001$. The significant quadratic term indicates a downturn in the curve (i.e., inverted-U shaped distribution), with the peak effect at 0.69 and with the asymptote occurring at 35.73 exposures.

To investigate whether the inverted-U shaped distribution resulted from a subsample of studies that included large exposure frequencies (e.g., a study that included a condition in which a stimulus was exposed for a relatively large number of times), we conducted an additional analysis that included only exposure frequencies that were fewer than 50 (this cut-off was selected by [a] identifying a value beyond the asymptote for liking, plus uncertainty; and [b] via inspection of the distribution of exposure frequencies in our sample; see Table 2). If large exposure frequencies were responsible for the inverted-U shaped distribution, the negative quadratic term would no longer be significant or would become positive. After studies that included "large" exposure frequencies were removed (we removed 26 effects), the average effect for liking effects was represented with the equation, $y = .61058 + .01404x - .000413x^2$. The slope continued to be significant, $\chi^2(1) = 134.11$, $p < .001$, as did the quadratic term,

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[1] The estimated peak of the curve at 62.18 exposures is somewhat unexpected relative to the other estimated peaks identified by our analyses. However, it is important to note that estimates of the peak are highly unstable if the quadratic coefficient is near zero, as is the case here. For example, an increase by as little as 0.000004 in the quadratic component results in an estimated peak below 50 exposures. Hence, although it is intuitive to interpret the peak of the curve, such interpretations should be approached with caution for curves with very small quadratic components.

Table 2
*Means and Number of Effects (K) for Liking, Familiarity, and Recognition at Exposure Frequency*

| Measure type | Exposure frequency | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 17 | 20 | 24 | 25 | 27 | 30 | 32 | 40 | ≥50 |
| Liking | | | | | | | | | | | | | | | | | | | | | | | | | |
| mean | .53 | .58 | .58 | .65 | .59 | .60 | .60 | .68 | .62 | .69 | .60 | .69 | .49 | .78 | .65 | .58 | .76 | .62 | .56 | .61 | .72 | .71 | .58 | .53 | .59 |
| *k* | 110 | 126 | 84 | 49 | 39 | 97 | 10 | 13 | 30 | 30 | 73 | 11 | 3 | 8 | 29 | 24 | 8 | 22 | 3 | 41 | 16 | 2 | 6 | 19 | 26 |
| Recognition | | | | | | | | | | | | | | | | | | | | | | | | | |
| mean | .45 | .55 | .74 | .83 | .77 | .57 | .89 | .56 | .80 | .87 | .63 | — | — | — | .61 | .79 | — | .64 | — | — | .94 | .65 | .86 | — | .80 |
| *k* | 23 | 20 | 10 | 5 | 9 | 2 | 2 | 1 | 5 | 5 | 3 | 0 | 0 | 0 | 2 | 4 | 0 | 3 | 0 | 0 | 3 | 1 | 5 | 0 | 4 |
| Familiarity | | | | | | | | | | | | | | | | | | | | | | | | | |
| mean | .29 | .61 | .71 | .63 | .80 | .65 | .76 | .81 | .63 | .84 | .75 | .82 | .83 | 0 | .45 | .92 | 0 | .91 | — | — | .95 | — | — | — | — |
| *k* | 10 | 16 | 11 | 5 | 11 | 7 | 3 | 3 | 7 | 5 | 7 | 3 | 3 | 0 | 1 | 4 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |

*Note.* Means are weighted by the sample size of effects included at a specific exposure frequency. *k* is the number of effects at a specific exposure frequency.

$\chi^2(1) = 361.63$, $p < .001$, with the peak effect at 0.72 and with the asymptote occurring at 21.75 exposures. The significant quadratic term provides evidence that the downturn in the curve (i.e., inverted-U shaped distribution) did not result from "large" exposure frequencies.

## Are Exposure Effects Different for Subliminal Versus Supraliminal Exposure?

A discussion of what constitutes a "subliminal" effect is warranted. What is considered "subliminal" depends on many factors, including modality (auditory vs. visual), stimulus complexity (a photograph vs. a word), the use of forward/backward masking, among other factors (Marcel, 1983a, 1983b; Cheesman & Merikle, 1986). From a review of the literature, estimates for what is considered a "subliminal" presentation tended to vary between 5 ms and 30 ms. We selected the conservative—but still arbitrary—cutoff value of 15 ms. We selected this value to include as many "researcher-defined" subliminal studies as possible. It is important to note, however, that even if our cutoff is somewhat arbitrary, the cutoff continues to provide an adequate test of the predictions of mere exposure theories, as the predictions are relative in nature, such that very brief exposure durations should be associated with larger effects than longer exposure durations.

We collapsed all studies with exposure durations greater than 15 ms and compared them with studies with very brief exposure durations (≤15 ms). There was an effect for exposure duration, $\chi^2(3) = 312.41$, $p < .001$. The curve for very brief exposure studies, $y = .54417 + .00866x - .000157x^2$, included a significant positive slope and negative quadratic term, $\chi^2(1) = 148.02$, $p < .001$ and, $\chi^2(1) = 38.88$, $p < .001$, for the slope and quadratic term, respectively. The curve for longer duration studies, $y = .65417 + .00550x - .000082x^2$, also produced a significant positive slope and negative quadratic term, $\chi^2(1) = 65.79$, $p < .001$ and $\chi^2(1) = 45.30$, $p < .001$. The curve for very brief exposure effects, compared to longer exposure effects, was associated with a descriptively smaller intercept, larger positive slope, and larger negative quadratic term. The significant slope for very brief exposure effects is consistent with the proposition that conscious awareness is unnecessary for the operation of the mere exposure effect. The quadratic effect, however, was also significant, indicating that there was the reduction in liking even after repeated very brief exposures.[2]

## Descriptive Moderator Analyses

**Stimulus type.** We used Bornstein's (1989) categories to generate seven categories: auditory, ideograph, meaningful words, meaningless words, paintings, photographs, and other (e.g., a target person; Moreland & Beach, 1992). Only the affective effects (liking, pleasure) were included in this analysis (as with several moderator analyses that follow) to test the predictions of the various models for the mere exposure effect. There was a differ-

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[2] Bornstein (1989) also included very brief exposure studies that included recognition rates that were above/below chance as the standard for a "subliminal" study. Unfortunately, we were not able to replicate this analysis because too few studies both (a) used very brief exposure durations, and (b) included recognition rates.

Table 3
*Summary of the Moderators of the Mere Exposure Effect*

| | | | Chi-square test | | Quadratic maxima | |
|---|---|---|---|---|---|---|
| Moderator | Number of effects | Quadratic equation | Slope | Quadratic | Peak effect | Peak at exposure |
| Measure type | | | | | | |
| Auditory | 34 | $y = .70508 - .00167x + .000025x^2$ | $94.29^{**}$ | $65.88^{**}$ | — | — |
| Ideograph | 36 | $y = .60776 + .00368x - .000025x^2$ | $336.63^{**}$ | $90.69^{**}$ | .74 | 73.07 |
| Nonsense words | 26 | $y = .67876 + .00320x - .000057x^2$ | $291.23^{**}$ | $156.55^{**}$ | .72 | 27.98 |
| Paintings/drawing/matrice | 34 | $y = .66324 + .00659x - .000114x^2$ | $264.38^{**}$ | $205.42^{**}$ | .75 | 28.89 |
| Photograph | 23 | $y = .59375 + .00399x - .000081x^2$ | $170.19^{**}$ | $54.43^{**}$ | .64 | 24.43 |
| Polygons | 11 | $y = .56697 + .00454x - .000048x^2$ | $120.91^{**}$ | $44.61^{**}$ | .67 | 46.54 |
| Delay | | | | | | |
| Immediate | 21 | $y = .75338 + .00018x - .000008x^2$ | $9.83^{*}$ | 3.08 | .75 | 10.97 |
| All stimuli presented, immediate rating | 127 | $y = .64547 + .00172x - .000022x^2$ | $354.58^{**}$ | $143.01^{**}$ | .67 | 38.67 |
| All stimuli presented, delay before rating | 27 | $y = .65301 + .00434x - .000053x^2$ | $182.82^{**}$ | $68.04^{**}$ | .74 | 40.61 |
| Presentation type | | | | | | |
| Homogeneous | 15 | $y = .65582 + .00181x - .000023x^2$ | $62.83^{**}$ | $65.46^{**}$ | .69 | 38.75 |
| Heterogeneous | 154 | $y = .66220 + .00214x - .000041x^2$ | $413.08^{**}$ | $183.14^{**}$ | .68 | 25.66 |
| Age | | | | | | |
| Children | 12 | $y = .76670 + .01251x - .000384x^2$ | $212.25^{*}$ | $118.63^{*}$ | .86 | 16.29 |
| Adults | 164 | $y = .65440 + .00140x - .000018x^2$ | $805.66^{*}$ | $639.40^{*}$ | .68 | 37.41 |
| Measure type | | | | | | |
| Liking | 141 | $y = .66239 + .00173x - .000025x^2$ | $383.29^{**}$ | $206.10^{**}$ | .69 | 34.39 |
| Goodness/correctness | 30 | $y = .63714 + .00086x - .000006x^2$ | $24.01^{**}$ | $25.19^{**}$ | .66 | 70.41 |
| Pleasing | 35 | $y = .65827 + .00023x - .000029x^2$ | $56.48^{**}$ | $32.21^{**}$ | .70 | 39.11 |
| Recognition | 24 | $y = .66502 + .01715x - .000226x^2$ | $2848.20^{**}$ | $1663.72^{**}$ | .98 | 37.79 |
| Familiarity | 17 | $y = .45714 + .06708x - .001971x^2$ | $2062.42^{**}$ | $767.35^{**}$ | 1.02 | 17.01 |
| Other | 21 | $y = .66078 + .00692x - .000193x^2$ | $51.24^{***}$ | $41.08^{**}$ | .72 | 17.83 |
| Exposure duration | | | | | | |
| ≤15 ms | 24 | $y = .54436 + .00867x - .000157x^2$ | $148.02^{**}$ | $38.88^{**}$ | .66 | 27.48 |
| 16 ms–999 ms | 7 | $y = .54988 + .00165x - .000052x^2$ | $6.78^{*}$ | 2.76 | .56 | 15.73 |
| 1 s–4 s | 80 | $y = .65127 + .00356x - .000035x^2$ | $555.28^{**}$ | $232.03^{**}$ | .74 | 50.57 |
| 5 s–10 s | 8 | $y = .75637 + .00203x - .000044x^2$ | $9.10^{*}$ | $10.98^{**}$ | .77 | 22.97 |
| 11 s–59 s | 17 | $y = .73831 - .00235x + .000033x^2$ | $146.43^{**}$ | $88.88^{**}$ | — | — |
| ≥60 s | 22 | $y = .65257 + .00886x - .000392x^2$ | $121.22^{**}$ | $88.66^{**}$ | .70 | 11.28 |
| Exposure Duration × Total # of Exposures | | | | | | |
| <2 s | 25 | $y = .59619 + .01092x - .000206x^2$ | $258.52^{**}$ | $112.42^{**}$ | .74 | 26.41 |
| 2 s–1 m 28 s | 27 | $y = .64467 + .00176x - .000056x^2$ | $96.92^{**}$ | $46.59^{**}$ | .78 | 41.81 |
| 1 m 29s–2 m 40 s | 30 | $y = .58078 + .00330x - .000063x^2$ | $403.62^{**}$ | .50 | .62 | 26.16 |
| 2 m 41 s–4 m 18 s | 31 | $y = .64236 + .00061x - .000008x^2$ | $78.04^{**}$ | $93.92^{**}$ | .65 | 35.76 |
| 4 m 19 s–15 m 45 s | 36 | $y = .65191 + .00183x - .000012x^2$ | $136.57^{**}$ | $60.06^{**}$ | .72 | 76.62 |
| >15 m 45 s | 35 | $y = .69821 - .00179x + .000025x^2$ | $139.18^{**}$ | $81.06^{**}$ | — | — |
| Interstimulus interval | | | | | | |
| <60 ms | 10 | $y = .52032 + .00021x + .000013x^2$ | $38.25^{**}$ | 2.33 | — | — |
| 70 ms–999 ms | 24 | $y = .63636 + .00103x - .000011x^2$ | .11 | $0^{\dagger}$ | .65 | 45.29 |
| 1 s–2.99 s | 42 | $y = .59995 + .00218x - .000009x^2$ | $228.28^{**}$ | $34.32^{**}$ | .72 | 113.72 |
| 3 s–30 s | 36 | $y = .67991 + .01191x - .000244x^2$ | $277.96^{**}$ | $85.29^{**}$ | .82 | 24.42 |
| >30 s | 13 | $y = .73738 + .00852x - .000401x^2$ | $77.70^{**}$ | $74.41^{**}$ | .78 | 10.60 |

*Note.* Empty cells indicate values that could not be estimated. Due to missing values, the number of effects for a specific moderator may not total to 268 (for analyses that included all effect sizes) or 176 (for those analyses that investigated liking/pleasing).

$^{\dagger}$ A slightly negative value was obtained and truncated to zero. In principle, likelihood-ratio tests of nested models cannot produce values less than zero. This phenomenon can happen on occasion due to numerical instability in the estimation procedure. $^{*}p < .05$. $^{**}p < .001$.

ence among the categories, $\chi^2(15) = 962.58$, $p < .001$. The results are presented in Table 3 and illustrated in Figure 1. Results revealed a general trend for positive slopes and negative quadratic terms for all stimulus types except for auditory stimuli, which demonstrated a negative slope but positive quadratic term, indicating a U-shaped curvature.

***Simple versus complex stimuli.*** To test specific predictions for several mere exposure effect models, we collapsed categories that, on average, are more complex (paintings, photographs) versus more simple (ideographs, polygons). There was an effect for stimulus complexity, $\chi^2(3) = 129.21$, $p < .001$. The curve for simple effects, $y = .63895 + .00404x - .000070x^2$, includes a significant slope and quadratic term, $\chi^2(1) = 439.82$, $p < .001$ and $\chi^2(1) = 245.97$, $p < .001$ (max at peak = 28.55; peak effect = 0.70). The curve for complex effects, $y = .60033 + .00352x - .000026x^2$, also includes a significant slope and quadratic term, $\chi^2(1) = 515.23$, $p < .001$ and $\chi^2(1) = 138.79$, $p < .001$ (max at peak = 66.27; peak effect = 0.72). The curve for simple stimuli, compared to complex stimuli, was associated with a descriptively smaller intercept, but larger slope and quadratic term.

***Auditory versus visual stimuli.*** We also collapsed stimuli into auditory and visual categories. There was a significant effect for

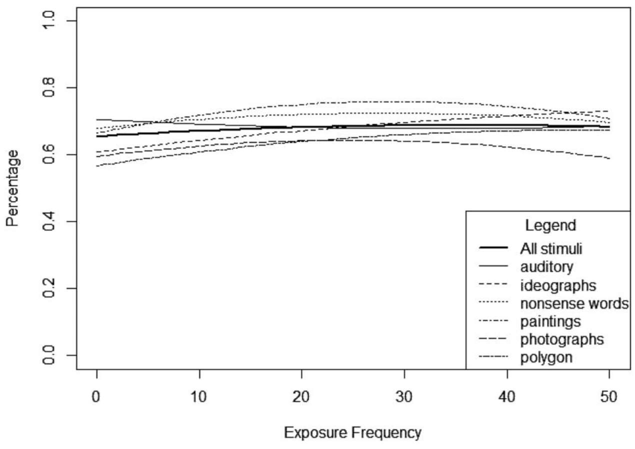

*Figure 1.* Effect sizes as a function of stimulus type and number of exposures.

audio/visual stimulus type, $\chi^2(3) = 657.36$, $p < .001$. The curve for visual stimuli revealed a positive slope and negative quadratic term, $y = .64160 + .00299x - .000037x^2$, both of which were significant, $\chi^2(1) = 950.82$, $p < .001$ and $\chi^2(1) = 353.35$, $p < .001$, respectively. The auditory estimate revealed a negative slope and positive quadratic term, $y = .70456 - .00167x + .000025x^2$, both of which reached significance, $\chi^2(1) = 94.29$, $p < .001$ and $\chi^2(1) = 65.87$, $p < .001$. This finding indicates that the mere exposure effect applies to visual stimuli but not to auditory stimuli.

**Delay.** Following Bornstein (1989), we sorted effects into one of three categories: immediate assessment after each stimulus exposure, assessment immediately after the final presentation of the exposure phase, or assessment following the exposure phase and delay (of any duration). For the affective effects, there was a significant difference among the categories, $\chi^2(6) = 154.88$, $p < .001$. As graphed in Figure 2 and presented in Table 3, each delay type was paired with a positive slope and negative quadratic term, although the negative quadratic term for immediate assessment was not significant.

**Presentation type.** Only the affective effects were included. There was a difference between the curves for studies that used a homogeneous versus heterogeneous presentation of stimuli, $\chi^2(3) = 30.13$, $p < .001$. Homogeneous presentations, compared with heterogeneous presentations, were characterized by a descriptively larger slope, but smaller quadratic term.

**Age.** We categorized effects by participants' age. The child sample was comprised of individuals younger than 18 years of age, whereas the adult sample was primarily composed of college-aged individuals. Testing the affective effects only, we found an effect for age, $\chi^2(3) = 639.94$, $p < .001$. As graphed in Figure 3, there was a positive slope and negative quadratic term for each age group, but the slope and quadratic terms for children were more dramatic than they were for adults.

**Measure type.** Using Bornstein's (1989) categories, we uncovered an effect for measure type, $\chi^2(15) = 6083.44$, $p < .001$. As graphed in Figure 4, each measure was associated with a significant positive slope and a negative quadratic term. The online supplement presents the individual curves for each measurement type.

**Exposure duration.** We followed the category distinctions as identified by Bornstein (1989), but added in the theoretically relevant "very brief" exposure (<15 ms) category. For the affective effects, there was a significant difference among the categories, $\chi^2(15) = 1024.75$, $p < .001$. The curves are plotted in Figure 5. Results indicate that there was a descriptive pattern such that the largest effect (large peak effect and largest peak exposure) was for exposures that lasted 1 s–4 s. Results also revealed that the intercept and slope for short exposures (less than 15 ms and those between 16 ms and 1 s) were both smaller than the average effects and the effects for longer exposure durations. The curve for longer exposures (≥60 s) produced a relatively rapid decline after a few exposures. Interestingly, exposure durations that lasted between 11 s and 59 s produced a negative slope and positive quadratic term, producing a U-shaped distribution.

Sensitivity analyses revealed that the slope and quadratic term dropped to nonsignificant for two exposure durations when the variance term was tripled: for 5 s–10 s, quadratic term, $\chi^2(1) = 3.27$, $p = .07$; $\geq 60$ s, slope, $\chi^2(1) = 2.69$, $p = .10$, quadratic term,

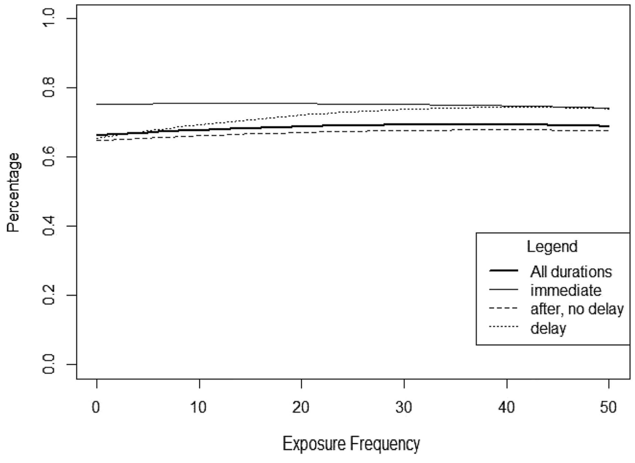

*Figure 2.* Effect sizes as a function of delay type and number of exposures.

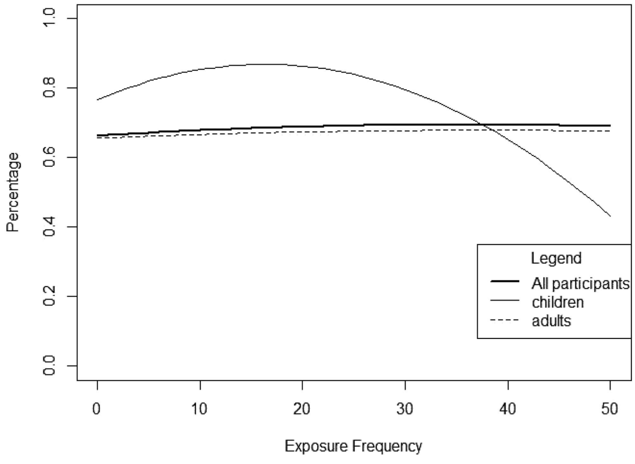

*Figure 3.* Effect sizes as a function of participant age and number of exposures.

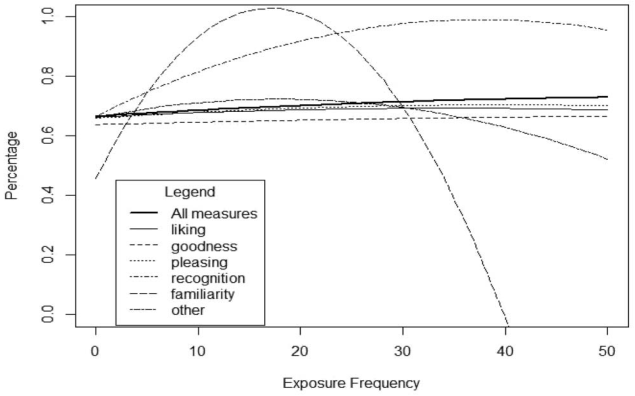

*Figure 4.* Effect sizes as a function of measure type and number of exposures.

$\chi^2(1) = 0.69$, $p = .40$. In addition, the quadratic effect for 16 ms–999 ms changed from not significant to significant, $\chi^2(1) = 5.19$, $p < .05$.

## Exploratory Analyses

**Exposure Duration × Complex/Simple Stimuli.** An extension of the basic prediction of most models of the mere exposure effect is that simple, compared to complex, stimuli presented for a short (vs. long) duration would be associated with a greater negative quadratic effect (due to boredom, habituation, etc.). To investigate this prediction, we estimated the curves for simple/complex stimulus type relative to long/short exposure duration.

For "short" exposure durations (≤1s), there was a difference for complexity, $\chi^2(3) = 26.19$, $p < .001$. For complex stimuli ($k = 32$), the curve, $y = .57869 + .00196x - .000016x^2$, included a significant slope, $\chi^2(1) = 84.37$, $p < .001$, and quadratic term, $\chi^2(1) = 12.70$, $p < .001$. Alternatively, the curve for simple stimuli ($k = 15$), $y = .55042 + .00322x - .000019x^2$, also included a significant slope, $\chi^2(1) = 225.56$, $p < .001$, and quadratic term, $\chi^2(1) = 55.84$, $p < .001$.

For "long" exposure durations (≥1 s), there was a significant difference for complexity, $\chi^2(3) = 10.13$, $p < .01$. For complex stimuli ($k = 16$), the curve, $y = .65148 + .00901x - .000174x^2$, was associated with a significant slope, $\chi^2(1) = 494.73$, $p < .001$, and quadratic term, $\chi^2(1) = 409.67$, $p < .001$. Alternatively, for simple stimuli ($k = 37$), the curve, $y = .67713 + .01016x - .000215x^2$, also was associated with a significant slope, $\chi^2(1) = 446.13$, $p < .001$, and quadratic term, $\chi^2(1) = 286.37$, $p < .001$.

Results revealed statistically significant simple effects for complexity by long/short exposure duration, but inspection of the curve estimates revealed that the larger difference was between long versus short exposure durations. It is important to note that of the 32 articles that contributed data for this analysis, only five (15%) contributed effects to both simple and complex categories; indicating that these nearly identical effect estimates were estimated using a spectrum of methods and procedures.

**Study duration.** Analogous to Bornstein's (1989) analysis that explored whether the maximum exposure frequency affected the magnitude of the mere exposure effect, we explored whether more time spent in the study results in an inverted-U shaped distribution. In other words, does the downturn in liking result from long studies? To test this, we multiplied exposure duration by the total number of exposures the participant saw to determine whether more time in the study would be associated with a greater downturn in liking.

We found an effect for study duration, $\chi^2(15) = 1289.17$, $p < .001$. Results indicated that each category of study duration shorter than 15 min and 45 s was associated with a positive slope and negative quadratic term, whereas the category associated with the longest studies was associated with a negative slope and positive quadratic effect.

Sensitivity analyses revealed that one of the quadratic effects for study duration changed from nonsignificant to significant when the sampling variance term was tripled: for 1 m 29 s–2 m 40 s, $\chi^2(1) = 4.53$, $p < .05$.

**Interstimulus interval.** We found a significant effect for ISI, $\chi^2(12) = 608.16$, $p < .001$. As illustrated in Figure 6, brief ISIs were the only effects resulting in a positive slope and a *positive* quadratic effect, whereas studies with longer ISIs were all associated with positive slopes but negative quadratic terms.

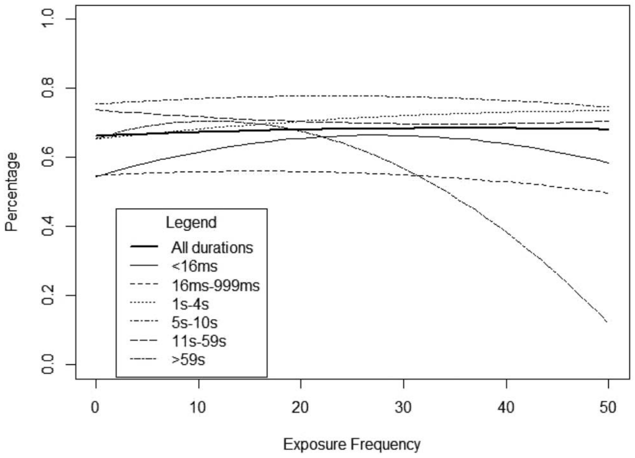

*Figure 5.* Effect sizes as a function of exposure duration and number of exposures.

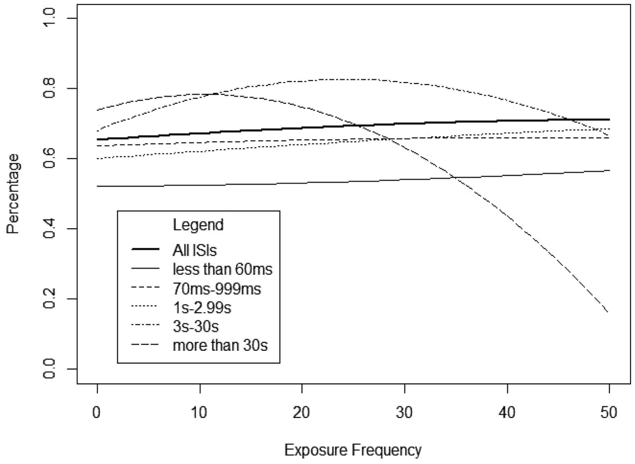

*Figure 6.* Effect sizes as a function of interstimulus interval (ISI) and number of exposures.

Sensitivity analyses revealed that the slope and quadratic terms for ISIs changed when the variance term was tripled: for 70 ms–999 ms, significant effects were observed for slope, $\chi^2(1) = 9.69$, $p < .05$, and the quadratic term, $\chi^2(1) = 10.71$, $p < .01$; for >30 s, nonsignificant effects were noted for the slope, $\chi^2(1) = 0.01$, $p = .89$, and quadratic term, $\chi^2(1) = 0.06$, $p = .97$.

## Selection Bias

Given that researchers who study the mere exposure effect are typically interested in demonstrating change associated with the number of exposures, it is most likely that any selection bias effects would be evident in the slope component from the growth curve. Funnel plots (Light & Pillemer, 1984) provide a visual check for selection bias. In their original form, the plots present effect size plotted against sample size, which in the absence of bias, should take the shape of a symmetric funnel with less variation for the larger studies. Figure 7 presents a modified funnel plot in which the slopes are plotted against their standard errors. This form of the plot can be more informative than traditional funnel plots in which effects are plotted against sample size, as the range in which asymmetry is likely to arise is extended further, making problems easier to discern (Sutton, 2009). As with plots plotted against sample sizes, vertical symmetry would indicate the absence of bias.

In the present plot, there is apparent evidence of asymmetry, suggesting that some smaller slope effects may have been suppressed. Although the slopes for the largest studies (which appear as the very dense region at the left edge of the plot) are solidly greater than zero, there is a systematic tendency for effects from studies with larger standard errors to be positive rather than negative. Egger's regression test for asymmetry supports that idea, $t(266) = 6.52$, $p < .001$ (Egger, Davey Smith, Schneider, & Minder, 1997). However, it is important to note that the effects of such asymmetry may be negligible, as the overwhelming majority of the largest studies show positive effects. As a further check, we performed a trim-and-fill analysis (Duval & Tweedie, 2000). The trim-and-fill method works by estimating the number of missing effects and imputing the missing values symmetrically about the axis of the plot. The meta-analysis is then recalculated and the number of missing effects is reestimated. This process iterates until there are no further changes. For the mere exposure slopes, the trim-and-fill algorithm estimated that no effects were missing, so that there was no adjustment to the mean slope.

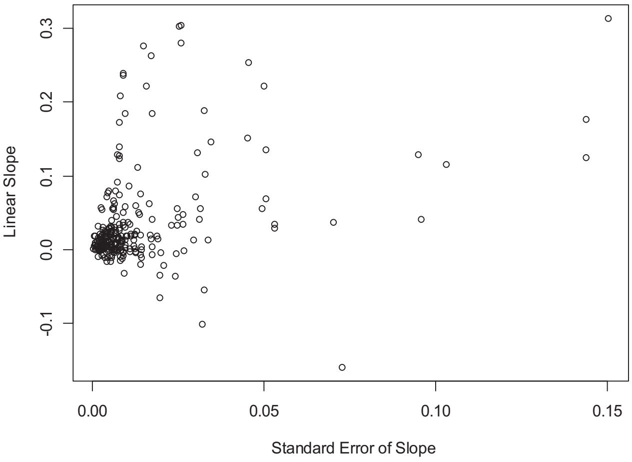

*Figure 7.* Plot of linear slope against standard error.

## Discussion

The goals of this synthesis were (a) to explore the processes that regulate the mere exposure effect, and (b) to determine how well established theories account for the data. We synthesized 268 effects using a meta-analysis of growth curves and found linear and quadratic effects of repeated exposure and moderating effects of numerous variables. Repeated exposure was associated with a more positive evaluation of the stimulus, although the magnitude of the slope was small. We also observed an inverted-U shaped relation between exposure frequency and liking. Across the different moderators, there was tremendous consistency of positive slopes and negative quadratic terms, but exposure effects were smaller (i.e., nonsignificant positive slope or negative slopes) or absent for longer study durations and auditory stimuli. In only one instance (specifically, very brief ISIs) did we find effects that produced both a positive slope and a (nonsignificant) positive quadratic term. Importantly, results from the sensitivity analyses revealed that the findings were robust and that they largely held when the sampling variance was tripled; one exception to this were effects that were characterized by long exposures. In the following sections, we review how the meta-analytic results speak to the critical questions and, when appropriate, the descriptive moderators. We then discuss what the results suggest about existing models, and we conclude by proposing a new framework for the mere exposure effect.

### Is There an Inverted-U Shaped Relation Between Exposure and Liking?

Across measure type, stimulus type, and different exposure durations, we found consistent inverted-U shaped relations (i.e., positive slopes and negative quadratic terms). All of the mere exposure models predicted that such a result was possible, but did so for different reasons. As discussed below, none of the models adequately explain the body of findings.

**The case for boredom.** Three theories proposed that boredom reduces liking to frequently viewed stimuli. Specifically, the original and modified two-factor models posited that boredom reduces liking for repeated stimuli via "stimulus satiation." Alternatively, fluency researchers propose that people attribute the experience of boredom to the frequently seen stimuli (Van den Bergh & Vrana, 1998).

However, research into boredom does not agree with these views. Boredom is considered an aversive state created by monotonous stimulation, which can develop quickly and is situation-specific (Hill & Perkins, 1985). O'Hanlon (1981) reviewed the impact of boredom in a wide range of contexts (e.g., school, industry, health) and concluded that boredom has a global impact on one's evaluations. Thus, boredom, as a psychological state, should have a global impact on *all* of the presented stimuli (i.e., produce a nonsignificant slope and/or lower intercept), not simply selected stimuli or those viewed most frequently (i.e., produce a significant negative quadratic term). Thus, previous work on boredom's effects does not support its role in the observed quadratic effect of exposure on liking.

The most direct test of the influence of boredom, then, would be a nonsignificant positive slope (or negative slope) for those studies that are likely to generate boredom, namely, long studies (Stang & O'Connell, 1974), long exposure duration studies (Hamid, 1973), long ISI studies, or studies that use only simple stimuli (Heyduk, 1975). In each case, however, we found comparable positive slopes and negative quadratic terms across all conditions. Interestingly, with respect to the study length, as outlined in Table 3, the longest studies were paired with a *negative* slope and it was the shortest studies that were associated with the largest negative quadratic term. For reasons that will become apparent, the negative slope for the longest studies should be interpreted with caution, as other factors beyond boredom may have contributed to this finding.

**The case for strategic responding/misattribution.** Fluency researchers propose that the quadratic effect may occur when individuals attribute the experience of fluency to previous exposures and less so to the stimulus. Our results do not allow us to exclude conclusively this explanation; however, two findings are inconsistent with it. To start, the negative quadratic effect for very brief exposure durations (i.e., ≤ 15 ms) defies explanation by misattribution. Indeed, without conscious recognition, misattribution could not influence people's responses. It is also telling that the negative quadratic effect for very brief exposures was equal to or larger than the negative quadratic effect for longer exposures, for which recognition, and thus the misattribution explanation, would seem more likely. Second, the negative quadratic term for delayed assessment studies was significant, compared to the nonsignificant negative quadratic term for immediate assessment studies. Given that delayed assessment should reduce awareness of and, thus, misattribution to, repeated exposure, relative to immediate assessment, this result speaks against a role for misattribution in creating the inverted-U shaped pattern.

**The case for habituation.** The fluency account includes the notion that repeated exposure results in habituation, which primarily occurs with longer exposure durations (Huber et al., 2008; Irwin, Huber, & Winkielman, 2010). More specifically, repeated exposure should produce *smaller slopes* when stimuli are viewed frequently or for a longer period of time (Huber et al., 2008). From this view, on repeated or extended exposure, the greater neural firing fatigues neurons, eventually reducing their synaptic communication. The reduced firing rate then produces less liking and lowered recognition. We call this approach *habituation via fatigue*. This approach is consistent with other neuropsychological models of habituation, including camatosis (e.g., Tulving, 2002), synaptic depression (Abbott, Varela, Sen, & Nelson, 1997; Nelson, Varela, Sen, & Abbott, 1997), and decremental responses (Xiang & Brown, 1998).

A second perspective on the effects of habituation indicates that habituation results from learning rather than fatigue. According to this view, exposure to a novel stimulus leads to more neural activation than does exposure to a familiar stimulus (Henson, Shallice, & Dolan, 2000). On initial exposures, the representation of that stimulus is not well-learned and it activates neural activity in parahippocampal areas (e.g., perirhinal and entorhinal cortices, Riches, Wilson, & Brown, 1991; Suzuki, Miller, & Desimone, 1997). After a sufficient number of repetitions, however, the representation is encoded and well-learned, resulting in a reduction in the neural response (i.e., habituation ensues). Such habituation reduces the amount of information that is passed on to long-term storage (primarily to the hippocampus; Li, Miller, & Desimone, 1993). From this perspective, lower liking and recognition results from this reduction in neural processing and encoding of that stimulus. This second approach, which we call *habituation via learning*, is consistent with phenomena that explain the reduced neural activity from learning, including adaptive mnemonic filtering (Miller, Li, & Desimone, 1993), cortical activity reduction (Dobbins, Schnyer, Verfaellie, & Schacter, 2004), repetition priming (Henson, Shallice, & Dolan, 2000), and repetition suppression (Desimone, 1996; Henson & Rugg, 2003).[3]

The current results provide strong support for habituation via learning approach, but inconsistent support for the habituation via fatigue account. Three points are particularly noteworthy: (a) very brief exposures for liking produced a significant negative quadratic effect; (b) all measure types generated a negative quadratic effect (as illustrated in Table 3/Figure 4); and (c) very brief ISIs were associated with a *positive* quadratic term.

First, the negative quadratic term for very brief exposures points to an automatic process that operates without sufficient activation to induce fatigue (Rieth & Huber, 2010) or conscious awareness to affect attributional patterns (Bornstein & D'Agostino, 1994). Second, the negative quadratic effects for all measure types points most directly to a process that occurs early in the stimulus response system that affects encoding generally, rather than solely to consciously processed stimuli or to liking assessments. Third, the magnitude of the quadratic term became larger and more negative with longer ISIs, which speaks against the habituation via fatigue account. After all, shorter ISIs provide less rest, and more fatigue, for neural systems. As such, from the habituation via fatigue perspective, such brief ISIs should have led to larger negative quadratic terms.

But how are these results consistent with habituation via learning approach? First, ERP and MRI investigations note that habituation effects occur rapidly; however, the reduced neural response (approximately 50%–67% reduction compared to the initial response, Ringo, 1996; Xiang & Brown, 1998) is estimated to occur between 70 ms (Xiang & Brown, 1998) and 200 ms–300 ms (e.g., Dale et al., 2000; Ringo, 1996) depending on the method of assessment. Dale et al. (2000), for instance, found that the neurological response was identical for novel and familiar stimuli at exposure, but after 250 ms, neural responses dropped dramatically for familiar stimuli (see also Grill-Spector, Kushnir, Hendler, & Malach, 2000, who identified a drop off at 120 ms). Importantly, this "inhibited habituation" effect occurred whether the stimuli that were presented between repetitions of the target stimuli were of same or different stimuli (e.g., Henson et al., 2000). Furthermore, this inhibited habituation effect appears to be task independent—whether the task was recognition or otherwise, inhibited habituation still occurred (Miller & Desimone, 1994; Sobotka & Ringo, 1993).

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[3] Although habituation via fatigue and habituation via learning are presented as two explanations for why habituation occurs, there are other explanations, including habituation to reduce interference (Ringo, 1996; Sobotka & Ringo, 1994) and habituation resulting from the inability to differentiate stimuli (Buttle, Ball, Zhang, & Raymond, 2005).

It is important to note that according to this view, it must follow that habituation serves to signal the latter neural cortices (e.g., hippocampus) that the stimulus is well-learned and encoded sufficiently. In other words, the reduced signal, *in and of itself*, indicates to later neural structures of the stimuli's familiarity. When habituation is not able to naturally occur (e.g., when ISIs are so short that another stimulus is presented before habituation can occur), the latter structures continue to treat the stimulus as a novel stimulus requiring further processing.

Thus, according to this interpretation, studies in which stimuli were paired with very brief ISIs were not associated with a significant negative quadratic effect because there was *insufficient time for habituation via learning to occur*. Indeed, from this perspective, habituation via learning resulted in reductions in neural responses (and thus ratings) only for those stimuli viewed most frequently (Henson et al., 2000; Henson et al., 2000; Xiang & Brown, 1998).

**Conclusion.** In general, the quadratic effects are consistent with predictions for processing fluency and two-factor model; however, a habituation via learning explanation, compared to a boredom, misattribution, or habituation via fatigue explanation, fares better in accounting for the totality of the meta-analytic findings.

## Relation Between Recognition, Familiarity, and Liking

The merits of the different mere exposure effect models can also be considered relative to the curves for recognition, familiarity, and liking. Three findings from this meta-analysis are noteworthy. First, familiarity, compared with liking or recognition, was descriptively acquired faster (i.e., had a larger slope) and was more quickly lost (i.e., larger negative quadratic term). Second, each of the three measures produced a significant negative quadratic effect. And third, very brief exposure durations produced a significant positive slope and negative quadratic term for liking. Below, we discuss the implications of these findings.

**Relation of familiarity to recognition.** The relatively rapid acquisition of familiarity is consistent with research that has explored the relation of familiarity and recognition. Specifically, familiarity (a) is more rapidly acquired than recognition (Hintzman & Caulton, 1997; Jacoby, 1999; Mandler, 1980; McElree, Dolan, & Jacoby, 1999); and (b) can serve as the foundation for recognition (Verfaellie & Cermak, 1999). Alternatively, the large negative quadratic term for familiarity is consistent with research that has proposed and found that familiarity (a) "dissipates" more quickly than recognition (e.g., Wixted & Mickes, 2010); and (b) leads to reduced neural firing, as compared to neuron activity in the face of novel stimuli (Miller, 1994). Models proposed by Juola, Fischler, Wood, and Atkinson (1971) and Tiberghien (1976) even go so far as to propose that the familiarity process should be *completed* before recognition, a finding consistent with the two divergent curves found in our analysis

**Relation of liking to familiarity and recognition.** The current data indicate that *both* familiarity and recognition are potentially important to liking, but the pattern of results does not align well with existing theories of the mere exposure effect. There are two observations that speak to this conclusion. First, the existence of a positive slope for liking with very brief exposure durations, in combination with the rapid ascent for familiarity, indicates that familiarity may lead to liking. In very brief exposure duration studies (<15 ms), recognition is not a factor (e.g., Bornstein, 1989; Kunst-Wilson & Zajonc, 1980; Murphy & Zajonc, 1993), which is consistent with the contention that liking can result from only the familiarity signal.

Second, the covariation of recognition with liking, particularly as evidenced by the similar peak exposure values for recognition and liking, indicates that recognition itself does *not* inhibit liking as is proposed by the two-factor and perceptual fluency models. Furthermore, the sequential nature of the familiarity and recognition peaks relative to liking is consistent with the notion that both familiarity and recognition may play a role in the mere exposure effect. Such a conclusion is also consistent with Mandler's (1980) influential article on recognition, which submits that familiarity and retrieval work together to produce recognition. From this perspective, retrieval of a stored representation of the presented stimulus is key, and comparisons of the presented stimuli to stored representations can be determined by either familiarity- or retrieval-related processes.

**Conclusion.** Existing models do not account well for the findings for familiarity, recognition, and liking, though each model predicts some aspect of the findings correctly. For instance, Zajonc's affective model, processing fluency, and the modified two-factor model predicted more liking as a result of the familiarity that results from very brief exposures. However, fluency models fall short by underestimating the relevance of recognition to liking as exposure frequency grows, a relevance the original two-factor model predicted accurately.

## Why Was There No Effect for Auditory Studies?

A surprising finding was the absence of a significant positive slope for auditory studies. The absence of an effect was unexpected given that: (a) all of the theoretical models expected an effect; (b) Bornstein (1989) found an effect for auditory studies; and (c) there was a consistently strong effect for visual stimuli across a wide range of durations and stimuli, which speaks to the robustness of the overall mere exposure effect. There are two plausible explanations for our failure to detect an effect: methodological considerations and the inherently valenced nature of musical-auditory stimuli. First, with respect to methodological considerations, in contrast to the "typical" visual exposure study, the "typical" auditory study included longer exposure durations (~90 seconds to 2 min), longer interstimulus intervals (~30 min), days or weeks between exposure sessions, and a long delay between exposure and test (days or weeks). It is possible that any one of these factors—or all in combination—were responsible. It is interesting to note that the auditory studies that were conducted akin to visual studies (e.g., Szpunar, Schellenberg, & Pliner, 2004) found consistent effects for repeated exposure. A second possibility is that stimuli used in auditory studies were not neutrally valenced. Given that a necessary precondition for selecting stimuli is participants' baseline unfamiliarity with the testing stimuli, researchers may have used stimuli that were not neutral, but negative (e.g., samplings of Pakistani folk music; Heingartner & Hall, 1974; music played at a discotheque). Importantly, research indicates that repeated exposure to disliked stimuli does not produce more liking (Craton & Lantos, 2011). As such, the lack of effect for auditory studies may be a result of the disliked stimuli rather than a genuine lack of effect for auditory stimuli.[4]

## Other Mere Exposure Effect Models

Over the past few years, a number of permutations of extant models have been proposed. Below, we briefly discuss their predictions relative to our findings.

**Hedonic fluency.** A key difference between hedonic fluency (e.g., Winkielman et al., 2003) and other processing fluency models (e.g., fluency/attribution model) is the assumption that the fluency cue itself is associated with positive affect. However, the current findings do not align with this view. To start, the hedonic fluency perspective predicts that the liking curve should align closely with the familiarity curve. However, as noted in Figure 5 and Table 3, the liking and familiarity lines diverged rapidly, with familiarity ascending and dropping dramatically after a relatively small number of exposure. Second, the hedonic fluency approach agrees with other fluency models that (a) misattribution leads to less liking when recognition is high, and (b) brief exposures lead to relatively more liking than longer exposures due to habituation via fatigue. As noted earlier, we found limited evidence for these predictions.

The hedonic fluency approach should not be confused with approaches that submit that familiarity is inherently tied to positive affect (e.g., Garcia-Marques & Mackie, 2000). As indicated by Figure 4 and by our discussion of the relation between liking, familiarity, and recognition, we found considerable evidence that familiarity alone (or more specifically, the positive experience that can result from familiarity) cannot account for the effects associated with the mere exposure effect.

**Relative fluency.** The relative fluency perspective (e.g., Wänke & Hansen, 2015) indicates that fluency is most informative when it is experienced as discrepant from a comparison standard. A direct test of this prediction is to examine the influence of homogeneous versus heterogeneous composition of the test list (i.e., whether the evaluated stimuli included both previously "seen" and "unseen" items [heterogeneous] vs. exclusively "seen" items [homogeneous]). Unfortunately, too few studies included this moderator to allow for its assessment. However, the finding that the test list composition influences recognition is also consistent with retrieval-induced forgetting (RIF; Anderson, Bjork, & Bjork, 1994). A meta-analysis of 143 studies that investigated moderators of RIF revealed that heterogeneous, versus homogeneous, word lists at test were associated with more forgetting (Murayama et al., 2014). Murayama et al. (2014) conclude that this finding was consistent with "inhibition," whereby attempts to retrieve a stimulus from memory results in multiple related stimuli to also be activated. To retrieve a specific stimulus, those related stimuli must be "inhibited," with such inhibition reducing later recall. Whether the effect of homogeneous/heterogeneous test lists results from RIF-based processes or from the relative fluency requires further investigation.

Although a direct test is unavailable given our data, one analysis that does investigate the influence of a comparison standard is the impact of between-participants versus within-participant designs. In between-participants designs, participants were only exposed to one level of exposure and were not exposed to "distractor" stimuli that could be used to provide a contrasting experience of fluency. A supplemental analysis of data provided support for the relative fluency prediction. That is, the curve for within studies, $y = .63205 + .00254x - .000011x^2$ (max peak = 114.64, peak effect = 0.77), included a descriptively larger slope than did the curve for between studies, $y = .50844 + .00590x - .000068x^2$ (max peak = 43.82, peak effect = 0.63), which reached statistical significance, $\chi^2(3) = 15.70$, $p < .05$. Both curves produced inverted-U shaped distributions, but the impact of repeated exposure was descriptively greater in within-effect designs, where a comparison standard was present. This finding is consistent with the role of relative fluency in the exposure effect.

**Pleasure-interest activation.** A recent variant of the fluency account, the pleasure-interest activation model (PIA; Graf & Landwehr, 2015), submits that fluency operates akin to dual process models, in which stimuli are processed via automatic (e.g., without conscious awareness, rapidly) and/or controlled (e.g., deliberate, effortful, motivated) processes. Whereas many of the predictions of PIA are identical to those predictions of most fluency models, there are important differences. Specifically, the model predicts that the inverted-U shaped distribution for liking characterizes the operation of controlled processes. However, as noted in Table 3, even very brief exposure durations were associated with a downturn, suggesting that the engagement of the controlled process is not necessary to produce such an effect. Also, PIA predicts that very brief exposure of complex stimuli produces a "monotonic decrease" in liking that results from the inability to eliminate disfluency. However, we identified similar inverted-U shaped distributions for both simple and complex stimuli even with a brief exposure duration.

**Embodiment theory.** Embodiment theory (Topolinski & Strack, 2009, 2010) proposes that exposure to stimuli is associated with a "covert simulation" of the typical motor response associated with that stimulus (e.g., exposure to words triggers the motoric response associated with reading and pronouncing those words). From this perspective, it is the (repeated) engagement of the sensorimotor activation that produces a more efficient motoric simulation, which is critical to the experience of processing fluency and thus, to the mere exposure effect. Topolinski (2012) went on to claim that motor fluency is "the driving causal force" (p. 37) for repeated exposure when words are used as stimuli.

This approach faces many of the same inconsistencies as do the traditional fluency accounts, as it must account for the (a) inverted-U shaped effects for very brief exposures, but also (b) the finding that the mere exposure curves were similar for the various visual stimulus types. However, we found considerable consistency of repeated exposure effects for various stimuli, including words, nonwords, photographs, and ideographs. Although this does not provide a "definitive test," the lack of a meaningful differences among stimuli that vary in the ease with which they are associated with sensorimotor systems does not support this approach.

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[4] Of course, this consideration also raises the more basic fundamental question of whether any mere exposure study is truly a "mere exposure effect study." Put another way, if the mere exposure effect applies only to "neutrally valenced" stimuli and exposure leads to more liking for that stimulus, the question becomes whether any effect beyond the first exposure (or measurement/assessment) is still considered the purview of "the mere exposure effect."

## A Theoretical Model Based on the Meta-Analytic Findings

Despite the clear theoretical differences between the aforementioned mere exposure effect models, two elements are more or less shared by them: First, the models agree that an initial exposure produces a mental representation and subsequent exposures strengthen that representation (although for Zajonc [1980], this occurs after affective processing). Second, the models (save Zajonc and the two-factor model) agree that exposure to previously viewed stimuli produces habituation of neurological responses. These two elements also align with extensive evidence across different models of memory and with models for encoding information into long-term storage.

However, as discussed previously, models of the mere exposure effect must also describe: (a) the consequences of the habituation via learning mechanism (vs. boredom or habituation via fatigue); (b) the inverted-U shaped distribution for very brief exposure duration studies; and (c) the litany of findings from the various moderator analyses, including those for measurement type (in particular, the inverted-U shaped curves for liking, recognition, and familiarity), exposure duration, ISI, total experiment time, and delay. An effective model of the mere exposure effect must also align with research on the encoding of mental representations, encoding processes, habituation, and long-term memory processes. We, of course, do not suggest that the extant models of mere exposure are inconsistent with models of memory. Indeed, the two-factor model and processing fluency accounts were developed from well-supported dual-process models of memory (e.g., Jacoby et al., 1989; Mandler, 1980). However, none of these models described particularly well the body of meta-analytic findings reported here as they relate to liking of a stimulus object. None of the existing models meets each of these criteria, leaving open the key outstanding question—on which each of the mere exposure theories have differed—how does repeated activation of an existing mental representation produce more liking for that stimulus? We outline below a comprehensive model for the mere exposure effect that is consistent with both the meta-analytic findings and with existing models of memory and information processing.

This model, *the Representation-Matching Model* (RMM), begins with a basic process in which novel stimuli that match mental representations in memory are evaluated as "good" and "correct," and thus are evaluated favorably (i.e., "liked" more). This approach submits that the mere exposure effect results from the impact (conscious or nonconscious) of repeated exposure to a stimulus on the mental representation to which that stimulus is then matched. That is, the more a person is exposed to a particular stimulus, the more a person regards that stimulus as "correct" or "how it should be" (note that the most robust measurement type was "goodness/correctness," Table 3), and liking for that stimulus then results. In short, the meta-analytic findings, and the representation matching model, indicate that people, without conscious processing or (mis)attributional assessments, come to evaluate well-learned stimuli as "correct" and "how things should be."

With respect to the negative quadratic effect, this model submits that habituation via learning is responsible for the negative quadratic effects. That is, the model posits that the reduced signal that results from a stimulus being well-learned—in and of itself—is responsible for the downward deflection of the curves. As we explain below, this model aligns with the "laws" that regulate memory encoding and formation, and it aligns with the critical findings of this meta-analysis, including the inverted-U shaped relation between exposure frequency and liking, the relations among liking, familiarity, and recognition, and the moderating impact of delay, among other key findings.

**Relation between liking, familiarity, and recognition.** The results of this meta-analysis are consistent with the proposition that initial exposure to a novel stimulus engages familiarity-based processing associated with parahippocampal areas. Specifically, there is considerable evidence from the neuropsychology literature that (a) whereas familiarity is mediated by activity in the parahippocampal region (Eichenbaum, Otto, & Cohen, 1994; Yonelinas, 2002), a region that includes the perirhinal cortex (Brown & Aggleton, 2001) and the ventral tegmental area (Lisman & Grace, 2005), recognition is mediated by activation in the hippocampus and medial temporal lobes; and (b) that information is processed in the parahippocampal areas *before* it is processed by the hippocampus (e.g., Eichenbaum et al., 1994). From this theoretical perspective, the initial neural response in the parahippocampal areas is large because the perceptual representation is relatively unstable and unknown. On repeated exposure, the representation becomes progressively more stable until it is well-learned, with the number of exposures necessary varying by stimuli complexity and meaningfulness, among other factors. Via conscious or nonconscious repetition, a stimulus is considered familiar via sufficient encoding in the parahippocampus. Activation in the parahippocampus results in the experience of familiarity, whereas activation of a store representation from long-term memory results in recognition. As with dual-process models, familiarity processes precede recognition processes. The notion that both familiarity and recognition are important to the development of a perceptual representation is consistent with models of memory (e.g., Donaldson, 1996; Ingram, Mickes, & Wixted, 2012; Wixted, 2007). Either familiarity or recognition processes can be used to indicate that a stored representation is present, and because a stored representation is considered "correct" and "how the stimulus should be," liking results from that (repeated) exposure.

**Delay.** An emphasis on the evaluation of the stimulus as "correct" provides an explanation for why (a) a delay continues to produce the mere exposure effect, and (b) a delay produces a larger slope but larger negative quadratic effect than does immediate testing. To begin, as noted earlier, perceptual representations display impressive longevity, lasting for years once effectively created (e.g., Fahy, Riches, & Brown, 1993; Maylor, 1998; Mitchell, 2006). With respect to (a), perceptual representations exist and persist, and thus, the mere exposure effect persists. With respect to (b), however, although the perceptual representation is retained after a delay, the variability of what is considered to "match" the perceptual representation broadens. In other words, immediately after a representation has been learned, there is a strict definition of what matches the representation, but over time, the standards for what is considered a "match" are relaxed (Posner & Keele, 1968, p. 362).

**Summary.** The parameters of the representation-matching model are based on the findings of this meta-analysis and in conjunction with established models of memory. Beyond the findings of this meta-analysis, specific studies investigating the mere exposure effect also provide evidence consistent with the predictions of the representation-matching model. For instance, (a) prototypicality (as a proxy for "good"/"correct") is related to how attractive faces are judged to be (Jones & Hill, 1993; Light, Hollander, & Kayra-Stuart, 1981), and (b) assessments of prototypicality mediate the relation between repeated exposure and liking (e.g., Winkielman et al., 2006, Experiments 1, 2; Zebrowitz, White, & Wieneke, 2008).

It may appear that the representation-matching model is similar to the fluency approach. However, they differ in two specific ways: First, from the perspective of the representation-matching model, liking does not result from the experience of processing ease, speed, or fluency, but rather, from the match of the stimuli to a stored representation (a stored representation that is defined as "correct;" cf. "retrieval fluency," which refers to the ease/speed with which content is retrieved from memory; Kelley & Lindsay, 1993). Second, habituation is predicted to occur for both theoretical approaches, but for processing fluency, it results from fatigue, whereas for the representation-matching model, habituation results from learning.

## Recommendations for Future Research

Like previous reviews of the mere exposure effect (e.g., Stang, 1974), we call for enhanced experimental designs to provide more direct responses to the questions raised by the meta-analytic results. The conclusions of this meta-analysis point to five specific recommendations for future research. First, this meta-analysis consistently identified curvilinear patterns with repeated exposure, indicating that future research should expose participants to at least three levels of exposure to detect the nuanced relation between exposure and response measurements. Second, we found complex curvilinear patterns for recognition, familiarity, and liking, indicating the need to continue to monitor the relation between these measurements. Third, an unresolved question from the current meta-analysis is whether continuous (as investigated in this meta-analysis) versus "forced-choice" (and a related method, single dichotomous "yes/no" response item) measurements, produce similar exposure findings.

Fourth, clarity regarding the specific mechanisms that underlie the negative quadratic term of the liking/familiarity/recognition curve is critical. Although we have focused on habituation via learning as the likely culprit, it is possible that other psychological phenomena play a role, including rapid response learning (Dobbins, Schnyer, Verfaellie, & Schacter, 2004; Logan, 1990), "tuning curves" (Wiggs & Martin, 1998), retrieval-induced forgetting (Murayama et al., 2014), or changes to the standards used to determine whether a new stimulus "matches" an old stimulus (Posner & Keele, 1968). Similarly, future research would do well to differentiate between the different models for how habituation inhibits encoding (e.g., via overall less activation, Miller & Desimone, 1994; via fewer neurons responding to a stimulus, Wiggs & Martin, 1998; or via shortened processing time, Sobotka & Ringo, 1996).

Finally, the potential and critical role of ISI requires further investigation. We found that studies that included very brief ISIs were associated with positive quadratic effects, indicating that they were perhaps "immune" to the effects of habituation, whereas those studies with longer ISIs were paired with negative quadratic effects. Such a finding is ripe for further inquiry.

## Conclusion

The mere exposure effect raises a simple question "Why do we like a stimulus the more frequently we have seen it?" The answer, however, requires a relatively complicated response, involving an understanding of memory systems, habituation and inhibition, neural responsiveness, cognitive representation formation, and recognition and preference systems. This meta-analysis used growth curves to estimate the exposure effect and found tremendous consistency among effects for different stimuli, measurement instruments, modes of presentation, and exposure durations. We found that four popular theories of the exposure effect could not explain the body of meta-analytic findings, but some models (e.g., two-factor model) performed better than others (e.g., processing fluency). The representation matching model, a new model based on models of memory and the findings of this meta-analysis, provides a framework to guide future research into the influence of repeated exposure on judgment.

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(*Appendix follows*)

# Appendix

*Overview of the Codings Applied to Studies Included in the Meta-Analysis*

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Anand and Sternthal (1990) | 3/5/8 | 109 | — | 2 | 1 | — | — | 1 | 2 | 2 | y = .31666 + .14661x − .010722 × 2 |
| Bartlett (1973) | 1/3/5/7/9/13/15/17 | 50 | 72 | 2 | 1 | 33,600 | 120 | 1 | 1 | 2 | y = .99269 − .00701x + .000147 × 2 |
| Bartlett (1973) | 1/3/5/7/9/13/15/17 | 50 | 72 | 2 | 1 | 33,600 | 120 | 1 | 1 | 2 | y = 1.03078 − .01564x + .000442 × 2 |
| Bartlett (1973) | 1/3/5/7/9/13/15/17 | 50 | 72 | 2 | 1 | 33,600 | 120 | 1 | 1 | 2 | y = .77013 + .00545x − .000060 × 2 |
| Bartlett (1973) | 1/3/5/7/9/13/15/17 | 50 | 72 | 2 | 1 | 33,600 | 120 | 1 | 1 | 2 | y = .76658 + .01143x − .000355 × 2 |
| Bartlett (1973) | 1/3/5/7/9/13/15/17 | 49 | 72 | 2 | 1 | 33,600 | 120 | 1 | 1 | 2 | y = .90617 + .00082x − .000080 × 2 |
| Bartlett (1973) | 1/3/5/7/9/13/15/17 | 49 | 72 | 2 | 1 | 33,600 | 120 | 5 | 1 | 2 | y = 1.02668 − .01021x + .000326 × 2 |
| Bartlett (1973) | 1/3/5/7/9/13/15/17 | 49 | 72 | 2 | 1 | 33,600 | 120 | 5 | 1 | 2 | y = .69383 + .00204x − .000061 × 2 |
| Bartlett (1973) | 1/3/5/7/9/13/15/17 | 49 | 72 | 2 | 1 | 33,600 | 120 | 1 | 1 | 2 | y = .69707 + .01043x − .000351 × 2 |
| Belch and Belch (1984) | 1/3/5 | 69 | — | 2 | 9 | — | 30 | 1 | 2 | 2 | y = .82375 + .11583x − .026250 × 2 |
| Berger and Mitchell (1989) | 1/3/4 | 79 | — | 2 | 5 | — | 15 | 1 | 3 | 2 | y = .89166 − .15944x + .036111 × 2 |
| Bornstein and D'Agostino (1992), Study 1 | 0/1/5/10/20 | 120 | 180 | 1 | 5 | 2 | .005 | 1 | 2 | 2 | y = .54629 + .01115x − .000359 × 2 |
| Bornstein and D'Agostino (1992), Study 1 | 0/1/5/10/20 | 120 | 180 | 1 | 7 | 2 | .5 | 1 | 2 | 2 | y = .47716 − .00751x + .000379 × 2 |
| Bornstein and D'Agostino (1992), Study 1 | 0/1/5/10/20 | 120 | 180 | 1 | 5 | 2 | .5 | 1 | 2 | 2 | y = .53685 + .00082x + .000009 × 2 |
| Bornstein and D'Agostino (1992), Study 1 | 0/1/5/10/20 | 120 | 180 | 1 | 7 | 2 | .005 | 1 | 2 | 2 | y = .52167 + .01659x − .000569 × 2 |
| Bornstein and D'Agostino (1992), Study 2 | 0/1/5/10/20 | 120 | 180 | 2 | 2 | 2 | .005 | 3 | 2 | 2 | y = .62378 + .01958x − .000580 × 2 |
| Bornstein and D'Agostino (1992), Study 2 | 0/1/5/10/20 | 120 | 180 | 2 | 5 | 2 | .5 | 1 | 2 | 2 | y = .63314 + .01157x − .000537 × 2 |
| Bornstein and D'Agostino (1992), Study 2 | 0/1/5/10/20 | 120 | 180 | 2 | 2 | 2 | .5 | 5 | 2 | 2 | y = .61209 + .01120x − .000406 × 2 |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bornstein and D'Agostino (1992), Study 2 | 0/1/5/10/20 | 120 | 180 | 2 | 5 | 2 | .005 | 5 | 2 | 2 | $y = .56418 + .01576x - .000334 \times 2$ |
| Bornstein, Kale, and Cornell (1990), Study 1 | 0/1/2/5/10/25/50 | 100 | 93 | — | 4 | — | 5 | 1 | 2 | 2 | $y = .78486 + .00319x - .000051 \times 2$ |
| Bornstein, Kale, and Cornell (1990), Study 2 | 0/1/2/5/10/25/50 | 100 | 186 | 1 | 4 | — | 5 | 1 | 2 | 2 | $y = .75461 + .00080x - .000061 \times 2$ |
| Bornstein, Kale, and Cornell (1990), Study 2 | 0/1/2/5/10/25/50 | 100 | 186 | 1 | 2 | — | 5 | 5 | 2 | 2 | $y = .57779 - .00984x + .000112 \times 2$ |
| Bornstein, Kale, and Cornell (1990), Study 3 | 0/1/2/5/10/25/50 | 100 | 93 | 2 | 4 | — | 5 | 1 | 2 | 2 | $y = .71564 + .00805x - .000124 \times 2$ |
| Bornstein, Kale, and Cornell (1990), Study 3 | 0/1/2/5/10/25/50 | 100 | 93 | 2 | 2 | — | 5 | 1 | 2 | 2 | $y = .65085 + .00512x - .000069 \times 2$ |
| Brentar, Neuendorf, and Armstrong (1994) | 1/8/16/24 | 44 | 16 | 2 | 1 | 9,600 | 120 | 1 | 2 | 2 | $y = .40189 + .01599x - .000710 \times 2$ |
| Brentar, Neuendorf, and Armstrong (1994) | 1/8/16/24 | 44 | 16 | 2 | 1 | 9,600 | 120 | 1 | 2 | 2 | $y = .63103 - .01271x + .000673 \times 2$ |
| Brentar, Neuendorf, and Armstrong (1994) | 1/8/16/24 | 44 | 16 | 2 | 1 | 9,600 | 120 | 7 | 2 | 2 | $y = .66176 - .01432x + .000719 \times 2$ |
| Brickman, Redfield, Harrison, and Crandall (1972), Study 1 | 0/1/2/5/10 | 22 | 28 | 2 | 1 | — | 90 | 1 | 2 | 2 | $y = .41948 - .00090x - .001778 \times 2$ |
| Brickman, Redfield, Harrison, and Crandall (1972), Study 1 | 0/1/2/5/10 | 23 | 28 | 2 | 1 | — | 90 | 1 | 2 | 2 | $y = .41929 + .04803x - .006238 \times 2$ |
| Brickman, Redfield, Harrison, and Crandall (1972), Study 2 | 0/1/2/5/10/25 | 36 | 86 | 2 | 2 | — | 4 | 1 | 2 | 2 | $y = .55378 + .01072x - .000164 \times 2$ |
| Brickman, Redfield, Harrison, and Crandall (1972), Study 2 | 0/1/2/5/10/25 | 36 | 86 | 2 | 2 | — | 4 | 10 | 2 | 2 | $y = .55094 + .00761x + .000061 \times 2$ |
| Brickman, Redfield, Harrison, and Crandall (1972), Study 2 | 0/1/2/5/10/25 | 36 | 86 | 2 | 2 | — | 4 | 10 | 2 | 2 | $y = .52402 + .01365x - .000028 \times 2$ |
| Brickman, Redfield, Harrison, and Crandall (1972), Study 2 | 0/1/2/5/10/25 | 36 | 86 | 2 | 2 | — | 4 | 10 | 2 | 2 | $y = .56697 + .00837x - .000134 \times 2$ |
| Brickman, Redfield, Harrison, and Crandall (1972), Study 3 | 1/2/5/10 | 48 | 18 | 2 | 4 | 3 | 3 | 2 | 2 | 2 | $y = .29398 + .03314x - .001779 \times 2$ |
| Brockner and Swap (1976) | 0/1/2/4/8 | 64 | 15 | 2 | 8 | — | 2.50 | 2 | 2 | 2 | $y = .81166 - .00483x + .001344 \times 2$ |
| Brooks and Watkins (1989), Study 3 | 0/1/3/9/27 | 20 | 80 | 2 | 2 | 5 | 2 | 2 | 2 | 2 | $y = .72828 + .01867x - .000597 \times 2$ |
| Brooks and Watkins (1989), Study 3 | 0/1/3/9/27 | 20 | 80 | 2 | 2 | 5 | 2 | 1 | 2 | 2 | $y = .59222 + .08606x - .002411 \times 2$ |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Brooks and Watkins (1989), Study 4 | 0/1/3/9/27 | 20 | 80 | 2 | 2 | 5 | 2 | 1 | 2 | 2 | $y = .72897 + .03391x - .001016 \times 2$ |
| Brooks and Watkins (1989), Study 4 | 0/1/3/9/27 | 20 | 80 | 2 | 2 | 5 | 2 | 1 | 2 | 2 | $y = .42743 + .11207x - .003148 \times 2$ |
| Brooks and Watkins (1989), Study 5 | 0/1/3/9/27 | 50 | 80 | 2 | 2 | 30 | 2 | 1 | 1 | 2 | $y = .74859 + .02102x - .000675 \times 2$ |
| Brooks and Watkins (1989), Study 5 | 0/1/3/9/27 | 50 | 80 | 2 | 2 | 30 | 2 | 1 | 1 | 2 | $y = .58945 + .09187x - .002663 \times 2$ |
| Bruce, Harman, and Turner (2007) | 0/2/4/6 | 56 | 288 | 2 | 10 | 3 | 1.5 | 10 | 3 | 2 | $y = .53940 + .22170x - .024250 \times 2$ |
| Bruce, Harman, and Turner (2007) | 0/2/4/6 | 56 | 288 | 2 | 10 | 3 | 1.5 | 10 | 3 | 2 | $y = .46420 + .27660x - .028500 \times 2$ |
| Bruce, Harman, and Turner (2007) | 0/2/4/6 | 56 | 288 | 2 | 10 | 3 | 1.5 | 10 | 3 | 2 | $y = .72580 + .03690x - .004750 \times 2$ |
| Bruce, Harman, and Turner (2007) | 0/2/4/6 | 56 | 288 | 2 | 10 | 3 | 1.5 | 1 | 3 | 2 | $y = .77210 + .00254x + .000125 \times 2$ |
| Cacioppo and Petty (1979) | 0/1/3/5 | 32 | — | 1 | 6 | — | — | 1 | 2 | 2 | $y = .24012 + .25354x - .042130 \times 2$ |
| Cacioppo and Petty (1979) | 0/1/3/5 | 32 | — | 1 | 6 | — | — | 1 | 2 | 2 | $y = .55179 + .15081x - .029190 \times 2$ |
| Campbell and Keller (2003) | 1/2/3 | 94 | 9 | 2 | 9 | — | — | 1 | 2 | 2 | $y = .48000 + .31333x - .068333 \times 2$ |
| Castillo (1985) | 0/1/2/5/10/25 | 85 | 86 | 2 | 2 | — | 4 | 10 | 3 | 2 | $y = .68771 + .01553x - .000467 \times 2$ |
| Castillo (1985) | 0/1/2/5/10/25 | 210 | 86 | 2 | 2 | — | 4 | 10 | 3 | 2 | $y = .68112 + .01754x - .000520 \times 2$ |
| Castillo (1985) | 0/1/2/5/10/25 | 41 | 86 | 2 | 2 | — | 4 | 10 | 3 | 2 | $y = .67279 + .01399x - .000421 \times 2$ |
| Compton, Williamson, Murphy, and Heller (2002), Study 1 | 1/2/4/8 | 38 | 180 | 2 | 5 | .05 | .05 | 10 | 2 | 2 | $y = .39197 + .05838x - .006700 \times 2$ |
| Compton, Williamson, Murphy, and Heller (2002), Study 1 | 1/2/4/8 | 38 | 180 | 2 | 5 | .05 | .05 | 1 | 2 | 2 | $y = .41604 + .03001x - .004221 \times 2$ |
| Compton, Williamson, Murphy, and Heller (2002), Study 1 | 1/2/4/8 | 38 | 180 | 2 | 5 | .05 | .05 | 10 | 2 | 2 | $y = .33969 + .01315x + .000795 \times 2$ |
| Compton, Williamson, Murphy, and Heller (2002), Study 1 | 1/2/4/8 | 38 | 180 | 2 | 5 | .05 | .05 | 1 | 2 | 2 | $y = .31907 + .07121x - .007338 \times 2$ |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Compton, Williamson, Murphy, and Heller (2002), Study 2 | 1/2/4/8 | 30 | 360 | 2 | 6 | .05 | .05 | 10 | 2 | 2 | y = .58024 + .03107x − .002767 × 2 |
| Compton, Williamson, Murphy, and Heller (2002), Study 2 | 1/2/4/8 | 30 | 360 | 2 | 3 | .05 | .05 | 1 | 2 | 2 | y = .71234 − .01585x + .001214 × 2 |
| Compton, Williamson, Murphy, and Heller (2002), Study 2 | 1/2/4/8 | 30 | 360 | 2 | 6 | .05 | .05 | 1 | 2 | 2 | y = .49125 + .05628x − .005501 × 2 |
| Compton, Williamson, Murphy, and Heller (2002), Study 2 | 1/2/4/8 | 30 | 360 | 2 | 3 | .05 | .05 | 1 | 2 | 2 | y = .38808 + .01359x − .001303 × 2 |
| Crandall (1972) | 1/2/5/10/25 | 230 | 43 | 2 | 3 | — | 3,000 | 1 | 3 | 2 | y = .52638 + .00831x − .000197 × 2 |
| Crandall, Montgomery, and Rees (1973), Study 3 | 10/20/30/40 | 80 | 100 | 2 | 3 | 1 | 7 | 1 | 2 | 2 | y = .59000 + .06295x − .001375 × 2 |
| Crandall, Montgomery, and Rees (1973), Study 4 | 10/20/30/40 | 80 | 100 | 2 | 3 | 1 | 7 | 4 | 2 | 2 | y = 1.50125 − .03427x + .000462 × 2 |
| de Zilva and Mitchell (2012) | 0/4/16/64 | 51 | 672 | 2 | 4 | .04 | 1 | 2 | 2 | 2 | y = .48578 + .00103x + .000007 × 2 |
| de Zilva and Mitchell (2012) | 0/4/16/64 | 39 | 672 | 2 | 7 | .04 | 1 | 2 | 2 | 2 | y = .46784 + .00701x − .000075 × 2 |
| de Zilva and Mitchell (2012) | 0/4/16/64 | 33 | 672 | 2 | 5 | .04 | 1 | 2 | 2 | 2 | y = .45743 + .00378x − .000048 × 2 |
| de Zilva and Mitchell (2012) | 0/4/16/64 | 29 | 672 | 2 | 7 | .04 | 1 | 1 | 2 | 2 | y = .53227 + .00264x − .000033 × 2 |
| de Zilva and Mitchell (2012) | 0/4/16/64 | 33 | 672 | 2 | 7 | .04 | 1 | 1 | 2 | 2 | y = .50507 + .00530x − .000054 × 2 |
| de Zilva and Mitchell (2012) | 0/4/16/64 | 26 | 672 | 2 | 7 | .04 | 1 | 1 | 2 | 2 | y = .50158 + .00261x − .000023 × 2 |
| de Zilva, Vu, Newell, and Pearson (2013) | 0/1/10/20 | 842 | 124 | 2 | 7 | 1 | 1 | 1 | 3 | 2 | y = .68332 + .00081x + .000012 × 2 |
| de Zilva, Vu, Newell, and Pearson (2013) | 0/1/10/20 | 842 | 124 | 2 | 7 | 1 | 1 | 1 | 3 | 2 | y = .60222 + .02085x − .000686 × 2 |
| Eaton (1996) | 0/1/2/3/4/6/8/9/10 | 197 | 43 | 2 | 9 | — | — | 1 | 3 | 3 | y = .44118 + .00937x − .001132 × 2 |
| Eaton (1996) | 0/1/2/3/4/6/8/9/10 | 197 | 43 | 2 | 9 | — | — | 1 | 3 | 3 | y = .30022 + .00377x + .000845 × 2 |
| Förster (2009), Study 1 | 0/5/15/40 | 29 | 180 | 2 | 4 | .539 | .01 | 2 | 3 | 2 | y = .42776 + .03017x − .000621 × 2 |
| Förster (2009), Study 2 | 0/5/15/40 | 37 | 180 | 2 | 4 | .539 | .01 | 2 | 3 | 2 | y = .55304 + .01915x − .000427 × 2 |
| Förster (2009), Study 2 | 0/5/15/40 | 37 | 180 | 2 | 4 | .539 | .01 | 7 | 3 | 2 | y = .57705 + .00986x − .000137 × 2 |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Garcia-Marques and Mackie (2001) | 0/1/2/4 | 60 | — | 1 | 1 | — | 62 | 7 | 2 | 2 | $y = .29901 + .10215x - .017992 \times 2$ |
| Garcia-Marques and Mackie (2001) | 0/1/2/4 | 60 | — | 1 | 1 | — | 68 | 1 | 2 | 2 | $y = .48174 - .05420x + .010037 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 1 | 0/5/15/40 | 22 | 120 | 2 | 2 | 1.16 | .014 | 1 | 2 | 2 | $y = .52222 + .00166x - .000089 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 1 | 0/5/15/40 | 22 | 120 | 2 | 2 | 1.16 | .014 | 1 | 2 | 2 | $y = .48732 + .01089x - .000239 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 1 | 0/5/15/40 | 22 | 120 | 2 | 2 | 1.16 | .014 | 1 | 2 | 2 | $y = .37471 + .02100x - .000361 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 1 | 0/5/15/40 | 19 | 120 | 2 | 2 | 1.16 | .014 | 1 | 2 | 2 | $y = .58872 + .00672x - .000244 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 1 | 0/5/15/40 | 19 | 120 | 2 | 2 | 1.16 | .014 | 1 | 2 | 2 | $y = .46623 + .02257x - .000478 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 1 | 0/5/15/40 | 19 | 120 | 2 | 2 | 1.16 | .014 | 1 | 2 | 2 | $y = .38635 + .02498x - .000410 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 2 | 0/5/15/40 | 14 | 120 | 2 | 2 | 1.16 | .014 | 1 | 2 | 2 | $y = .62290 - .00238x - .000056 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 2 | 0/5/15/40 | 14 | 120 | 2 | 2 | 1.16 | .014 | 5 | 2 | 2 | $y = .45960 + .01894x - .000394 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 2 | 0/5/15/40 | 14 | 120 | 2 | 2 | 1.16 | .014 | 5 | 2 | 2 | $y = .34472 + .02574x - .000415 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 2 | 0/5/15/40 | 20 | 120 | 2 | 2 | 1.16 | .014 | 1 | 2 | 2 | $y = .57766 - .00773x + .000125 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 2 | 0/5/15/40 | 20 | 120 | 2 | 2 | 1.16 | .014 | 1 | 2 | 2 | $y = .47805 + .00343x - .000028 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 2 | 0/5/15/40 | 20 | 120 | 2 | 2 | 1.16 | .014 | 3 | 2 | 2 | $y = .39707 + .01821x - .000259 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 3 | 0/5/15/40 | 14 | 120 | 2 | 2 | 1.16 | .014 | 1 | 2 | 2 | $y = .54850 - .00170x + .000016 \times 2$ |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gillebaart, Förster, and Rotteveel (2012), Study 3 | 0/5/15/40 | 14 | 120 | 2 | 2 | 1.16 | .014 | 1 | 2 | 2 | $y = .45218 - .00033x + .000087 \times 2$ |
| Gillebaart, Förster, and Rotteveel (2012), Study 3 | 0/5/15/40 | 14 | 120 | 2 | 2 | 1.16 | .014 | 2 | 2 | 2 | $y = .34878 + .01725x - .000242 \times 2$ |
| Goldberg and Gorn (1974) | 0/1/3 | 45 | — | 2 | 9 | — | — | 2 | 2 | 1 | $y = .67000 + .12875x - .036250 \times 2$ |
| Goldstein (1970) | 1/2/3/4 | 44 | 40 | 2 | 9 | — | 20 | 1 | 1 | 2 | $y = .75625 - .10125x + .006250 \times 2$ |
| Green, Bærentsen, Stødkilde-Jørgensen, Roepstorff, and Vuust (2012) | 0/2/8/32 | 21 | 126 | 2 | 1 | 2 | 13 | 1 | 2 | 3 | $y = .75305 + .00106x + .000043 \times 2$ |
| Green, Bærentsen, Stødkilde-Jørgensen, Roepstorff, and Vuust (2012) | 0/1/2/8/32 | 21 | 126 | 2 | 1 | 2 | 13 | 1 | 2 | 3 | $y = .51471 + .05703x - .001268 \times 2$ |
| Hamid (1973), Study 1 | 1/2/5/10/15/25 | 30 | 116 | 2 | 7 | 9.8 | 1 | 3 | 2 | 2 | $y = .50073 + .03028x - .000801 \times 2$ |
| Hamid (1973), Study 2 | 1/2/5/10/15 | 10 | 66 | 2 | 7 | 9.8 | 1 | 3 | 2 | 2 | $y = .52586 + .01442x - .000191 \times 2$ |
| Hamid (1973), Study 2 | 1/2/5/10/15 | 10 | 66 | 2 | 7 | 9.8 | 1 | 3 | 2 | 2 | $y = .45984 + .04132x - .001515 \times 2$ |
| Hargreaves (1984), Study 2 | 1/2/3/4/5/6/7/8/9/10/11/12 | 40 | 12 | 2 | 1 | 10 | 60 | 3 | 3 | 2 | $y = .67727 + .02618x - .001902 \times 2$ |
| Hargreaves (1984), Study 2 | 1/2/3/4/5/6/7/8/9/10/11/12 | 40 | 12 | 2 | 1 | 10 | 60 | 3 | 3 | 2 | $y = .57962 + .02066x - .000969 \times 2$ |
| Hargreaves (1984), Study 2 | 1/2/3/4/5/6/7/8/9/10/11/12 | 40 | 12 | 2 | 1 | 10 | 60 | 3 | 3 | 2 | $y = .31003 + .00118x + .000018 \times 2$ |
| Hargreaves (1984), Study 2 | 1/2/3/4/5/6/7/8/9/10/11/12 | 40 | 12 | 2 | 1 | 10 | 60 | 3 | 3 | 2 | $y = .45465 + .12734x - .006795 \times 2$ |
| Hargreaves (1984), Study 2 | 1/2/3/4/5/6/7/8/9/10/11/12 | 40 | 12 | 2 | 1 | 10 | 60 | 3 | 3 | 2 | $y = .28200 + .13942x - .006899 \times 2$ |
| Hargreaves (1984), Study 2 | 1/2/3/4/5/6/7/8/9/10/11/12 | 40 | 36 | 2 | 1 | 10 | 60 | 3 | 3 | 2 | $y = .06212 + .17322x - .009061 \times 2$ |
| Harrison and Crandall (1972), Study 1 | 0/1/3/9/27 | 40 | 80 | 1 | 2 | — | 15 | 3 | 2 | 2 | $y = .65598 - .00328x + .000134 \times 2$ |
| Harrison and Crandall (1972), Study 1 | 0/1/3/9/27 | 40 | 80 | 2 | 2 | — | 15 | 3 | 2 | 2 | $y = .53756 + .03459x - .000873 \times 2$ |
| Harrison and Crandall (1972), Study 2 | 1/3/9/27 | 40 | 80 | 1 | 2 | — | 15 | 2 | 2 | 2 | $y = .70885 - .00011x + .000104 \times 2$ |
| Harrison and Zajonc (1970) | 0/1/2/5/10/25 | 66 | 88 | 2 | 2 | — | 2 | 8 | 3 | 2 | $y = .65091 + .01337x - .000420 \times 2$ |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Harrison and Zajonc (1970) | 0/1/2/5/10/25 | 66 | 88 | 2 | 2 | — | 10 | 3 | 3 | 2 | y = .63847 + .00568x + .000105 × 2 |
| Hawkins, Hoch, and Meyers-Levy (2001) | 0/1/2/4 | 50 | 110 | 2 | 6 | — | 8 | 1 | 3 | 2 | y = .66824 + .04987x − .006212 × 2 |
| Hawkins, Hoch, and Meyers-Levy (2001) | 0/1/2/4 | 50 | 110 | 2 | 6 | — | 8 | 1 | 3 | 2 | y = .68416 + .04791x − .007083 × 2 |
| Hawkins, Hoch, and Meyers-Levy (2001) | 0/1/2/4 | 50 | 110 | 2 | 6 | — | 8 | 1 | 3 | 2 | y = .67428 + .07585x − .012689 × 2 |
| Hawkins, Hoch, and Meyers-Levy (2001) | 0/1/2/4 | 50 | 110 | 2 | 6 | — | 8 | 3 | 3 | 2 | y = .50266 + .30383x − .050833 × 2 |
| Hawkins, Hoch, and Meyers-Levy (2001) | 0/1/2/4 | 50 | 110 | 2 | 6 | — | 8 | 4 | 3 | 2 | y = .52015 + .27992x − .046590 × 2 |
| Hawkins, Hoch, and Meyers-Levy (2001) | 0/1/2/4 | 50 | 110 | 2 | 6 | — | 8 | 4 | 3 | 2 | y = .51925 + .30303x − .050871 × 2 |
| Heingartner and Hall (1974), Study 1 | 1/2/6/8 | 96 | 34 | 2 | 1 | 5 | 30 | 2 | 2 | 2 | y = .73315 + .01378x − .000320 × 2 |
| Heingartner and Hall (1974), Study 2 | 1/2/6/8 | 54 | 34 | 2 | 1 | — | 30 | 2 | 2 | 0 | y = .87726 − .00426x + .001747 × 2 |
| Hekkert, Thurgood, and Whitfield (2013) | 0/2/4/8/16 | 48 | 30 | 2 | 4 | — | — | 1 | 3 | 2 | y = .59051 + .01470x − .000500 × 2 |
| Hekkert, Thurgood, and Whitfield (2013) | 0/2/4/8/16 | 48 | 30 | 2 | 4 | — | — | 2 | 3 | 2 | y = .59102 + .02926x − .001028 × 2 |
| Hunter and Schellenberg (2011) | 0/2/8/32 | 79 | 84 | 2 | 1 | — | 15 | 2 | 2 | 2 | y = .71258 + .00541x − .000222 × 2 |
| Johnston (2016) | 0/1/2/3/4/5/6/7 | 96 | 10 | 1 | 1 | 10 | 60 | 2 | 1 | 2 | y = .59631 + .01834x − .000922 × 2 |
| Kail and Freeman (1973), Study 1 | 1/2/4/8/16 | 94 | 31 | 2 | 3 | — | 2 | 1 | 2 | 2 | y = .74705 + .02122x − .001178 × 2 |
| Kail and Freeman (1973), Study 1 | 1/2/4/8/16 | 94 | 31 | 1 | 3 | — | 2 | 1 | 2 | 2 | y = .70669 + .01842x − .000893 × 2 |
| Kail and Freeman (1973), Study 2 | 0/1/9/27/243 | 20 | 280 | 2 | 2 | 2.83 | .25 | 1 | 2 | 2 | y = .59288 + .00318x − .000007 × 2 |
| Kirmani (1997) | 2/3/5/7 | 166 | — | 2 | 5 | — | — | 1 | 2 | 2 | y = .83528 + .03500x − .006164 × 2 |
| Kohli, Harich, and Leuthesser (2005) | 1/2/3 | 30 | 3 | — | 6 | — | — | 1 | 1 | 2 | y = .88750 + .12500x − .025000 × 2 |
| Kohli, Harich, and Leuthesser (2005) | 1/2/3 | 30 | 3 | — | 3 | — | — | 1 | 1 | 2 | y = .48250 + .17625x − .026250 × 2 |
| Kruglanski, Freund, and Bar-Tal (1996), Study 2 | 0/1/3/9/27 | 40 | 80 | 2 | 4 | 5 | 2 | 1 | 2 | 1 | y = .84455 + .00043x − .000039 × 2 |
| Kruglanski, Freund, and Bar-Tal (1996), Study 2 | 0/1/3/9/27 | 40 | 80 | 2 | 4 | 5 | 2 | 4 | 2 | 1 | y = .77464 + .02321x − .000596 × 2 |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Kruglanski, Freund, and Bar-Tal (1996), Study 2 | 0/1/3/9/27 | 40 | 80 | 2 | 4 | 5 | 2 | 4 | 2 | 1 | $y = .62313 + .05420x - .001398 \times 2$ |
| Kruglanski, Freund, and Bar-Tal (1996), Study 2 | 0/1/3/9/27 | 40 | 80 | 2 | 4 | 5 | 2 | 4 | 2 | 1 | $y = .60875 + .06283x - .001688 \times 2$ |
| Kruglanski, Freund, and Bar-Tal (1996), Study 2 | 0/1/3/9/27 | 40 | 80 | 2 | 4 | 5 | 2 | 4 | 2 | 1 | $y = .63688 + .05613x - .001487 \times 2$ |
| Kruglanski, Freund, and Bar-Tal (1996), Study 3 | 0/1/3/9/27 | 22 | 40 | 2 | 4 | 5 | 2 | 1 | 2 | 1 | $y = .72276 + .03272x - .000799 \times 2$ |
| Kruglanski, Freund, and Bar-Tal (1996), Study 3 | 0/1/3/9/27 | 22 | 40 | 2 | 4 | 5 | 2 | 1 | 2 | 1 | $y = .86583 - .00028x + .000002 \times 2$ |
| Lee, Ahn, and Park (2015) | 1/3/8 | 41 | 12 | 2 | 4 | — | — | 2 | 2 | 2 | $y = .54961 + .03411x - .000404 \times 2$ |
| Lee, Ahn, and Park (2015) | 1/3/8 | 41 | 12 | 2 | 4 | — | — | 2 | 2 | 2 | $y = .62233 + .02883x - .002833 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 1 | 0/1/5/10/20 | 40 | 36 | 2 | 7 | — | 3 | 2 | 2 | 2 | $y = .64428 + .02474x - .001058 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 1 | 0/1/5/10/20 | 40 | 36 | 2 | 7 | — | 3 | 2 | 2 | 2 | $y = .64773 + .00581x + .000381 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 1 | 0/1/5/10/20 | 40 | 36 | 2 | 4 | — | 3 | 1 | 2 | 2 | $y = .59845 + .01633x - .000166 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 1 | 0/1/5/10/20 | 40 | 36 | 2 | 4 | — | 3 | 1 | 2 | 2 | $y = .65655 + .07946x - .002975 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 1 | 0/1/5/10/20 | 40 | 36 | 2 | 4 | — | 3 | 1 | 2 | 2 | $y = .40156 + .07724x - .002268 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 1 | 0/1/5/10/20 | 40 | 36 | 2 | 4 | — | 3 | 10 | 2 | 2 | $y = .34119 + .07171x - .001967 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 2 | 0/1/2/4/16 | 48 | 23 | 2 | 5 | — | 1 | 10 | 2 | 2 | $y = .68747 + .03061x - .001279 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 2 | 0/1/2/4/16 | 48 | 23 | 2 | 5 | — | 1 | 1 | 2 | 2 | $y = .58861 + .03041x - .001597 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 2 | 0/1/2/4/16 | 48 | 23 | 2 | 5 | — | 1 | 1 | 2 | 2 | $y = .55847 + .00662x - .000120 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 2 | 0/1/2/4/16 | 48 | 23 | 2 | 5 | — | 1 | 10 | 2 | 2 | $y = .38853 + .03940x - .002291 \times 2$ |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lee, Sundberg, and Bernstein (1993), Study 2 | 0/1/2/4/16 | 48 | 23 | 2 | 5 | — | 1 | 10 | 2 | 2 | $y = .49470 + .20889x - .010761 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 2 | 0/1/2/4/16 | 48 | 23 | 2 | 5 | — | 1 | 1 | 2 | 2 | $y = .46931 + .18488x - .009433 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 2 | 0/1/2/4/16 | 48 | 23 | 2 | 5 | — | 1 | 1 | 2 | 2 | $y = .37588 + .23881x - .012354 \times 2$ |
| Lee, Sundberg, and Bernstein (1993), Study 2 | 0/1/2/4/16 | 48 | 23 | 2 | 5 | — | 1 | 1 | 2 | 2 | $y = .39453 + .23667x - .012147 \times 2$ |
| Lu, Xie, and Liu (2015) | 3/9/15/21/30 | 138 | 60 | — | 9 | — | — | 1 | 2 | 2 | $y = .49926 + .02680x - .000865 \times 2$ |
| Matlin (1974) | 0/1/2/5/10/25 | 72 | 86 | 1 | 3 | — | 2400 | 1 | 3 | 2 | $y = .47158 + .02849x - .000911 \times 2$ |
| Matlin (1974) | 0/1/2/5/10/25 | 72 | 86 | 2 | 3 | — | 2400 | 3 | 3 | 2 | $y = .46725 + .02920x - .000851 \times 2$ |
| Matthes, Wirth, Schemer, and Kissling (2011) | 0/15/30 | 102 | — | — | 9 | — | — | 3 | 2 | 2 | $y = .31250 + .03116x - .000477 \times 2$ |
| Matthes, Wirth, Schemer, and Kissling (2011) | 0/7/15 | 94 | — | — | 9 | — | — | 4 | 2 | 2 | $y = .37750 + .05972x - .001848 \times 2$ |
| McCullough and Ostrom (1974) | 1/2/3/4/5 | 50 | 5 | 1 | 5 | — | 45 | 1 | 1 | 2 | $y = .07519 + .22251x - .030285 \times 2$ |
| McCullough and Ostrom (1974) | 1/2/3/4/5 | 50 | 5 | 1 | 5 | — | 45 | 1 | 1 | 2 | $y = .49120 + .05617x - .001428 \times 2$ |
| Montoya and Horton (2010), Study 1 | 0/1/2/5/10/20 | 93 | 186 | 2 | 2 | 3 | .01 | 1 | 3 | 2 | $y = .76377 - .00110x + .000021 \times 2$ |
| Montoya and Horton (2010), Study 1 | 0/1/2/5/10/20 | 124 | 186 | 2 | 2 | 3 | .01 | 1 | 3 | 2 | $y = .74385 + .00594x - .000155 \times 2$ |
| Montoya and Horton (2010), Study 1 | 0/1/2/5/10/20 | 93 | 186 | 2 | 2 | 3 | .01 | 5 | 3 | 2 | $y = .90767 + .01366x - .000556 \times 2$ |
| Montoya and Horton (2010), Study 1 | 0/1/2/5/10/20 | 124 | 186 | 2 | 2 | 3 | .01 | 5 | 3 | 2 | $y = .92716 + .02581x - .001010 \times 2$ |
| Montoya and Horton (2010), Study 2 | 0/1/2/5/10/20 | 90 | 186 | 2 | 2 | 3 | .01 | 1 | 3 | 2 | $y = .83198 - .00905x + .000456 \times 2$ |
| Montoya and Horton (2010), Study 2 | 0/1/2/5/10/20 | 93 | 186 | 2 | 2 | 3 | .01 | 1 | 3 | 2 | $y = .79633 + .00799x - .000330 \times 2$ |
| Montoya and Horton (2010), Study 2 | 0/1/2/5/10/20 | 90 | 186 | 2 | 2 | 3 | .01 | 5 | 3 | 2 | $y = .97094 - .00854x + .000479 \times 2$ |
| Montoya and Horton (2010), Study 2 | 0/1/2/5/10/20 | 93 | 186 | 2 | 2 | 3 | .01 | 5 | 3 | 2 | $y = .95667 + .00605x - .000151 \times 2$ |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Moorthy and Hawkins (2005) | 1/3/5 | 179 | — | 2 | 5 | — | — | 1 | 2 | 2 | $y = .62312 + .04125x - .000625 \times 2$ |
| Moreland and Beach (1992) | 0/1/3/9/27 | 50 | 80 | 2 | 2 | 5 | 2 | 1 | 2 | 2 | $y = .65974 + .02382x - .000571 \times 2$ |
| Moreland and Beach (1992) | 0/1/3/9/27 | 50 | 80 | 2 | 2 | 5 | 2 | 5 | 2 | 2 | $y = .59873 + .06596x - .001722 \times 2$ |
| Moreland and Zajonc (1977), Study 1 | 0/1/3/9/27 | 40 | 80 | 2 | 2 | 5 | 2 | 5 | 2 | 2 | $y = .55452 + .03096x - .000798 \times 2$ |
| Moreland and Zajonc (1977), Study 1 | 0/1/3/9/27 | 40 | 80 | 2 | 2 | 5 | 2 | 1 | 2 | 2 | $y = .56596 + .07449x - .002033 \times 2$ |
| Moreland and Zajonc (1977), Study 2 | 0/1/2/3 | 128 | 4 | — | 5 | 10,080 | 200 | 1 | 2 | 2 | $y = .56333 + .05083x + .004166 \times 2$ |
| Moreland and Zajonc (1977), Study 2 | 0/5/10/15 | 130 | 30 | 2 | 8 | — | — | 5 | — | 2 | $y = .46966 + .01226x - .000533 \times 2$ |
| Moreland and Zajonc (1982) | 0/5/10/15 | 130 | 30 | 2 | 8 | — | — | 5 | — | 2 | $y = .60041 + .01208x - .000216 \times 2$ |
| Nordhielm (2002) | 0/3/10/25 | 90 | 76 | 2 | 5 | — | 1 | 7 | 3 | 2 | $y = .58882 + .00525x - .000054 \times 2$ |
| Nordhielm (2002) | 0/3/10/25 | 90 | 76 | 2 | 5 | — | 1 | 7 | 3 | 2 | $y = .61138 + .00602x - .000258 \times 2$ |
| Oishi, Miao, Koo, Kisling, and Ratliff (2010) | 0/1/3/9 | 83 | 54 | 2 | 2 | .25 | 1 | 7 | 2 | 2 | $y = .55155 - .03274x + .004389 \times 2$ |
| Perlman and Oskamp (1971) | 0/1/5/10 | 32 | 59 | 2 | 5 | — | 2.5 | 7 | 2 | 2 | $y = .43775 - .00705x + .000656 \times 2$ |
| Rajecki and Wolfson (1973) | 0/1/3/6/10 | 41 | 20 | 2 | 3 | 86,400 | — | 9 | 3 | 2 | $y = .55503 + .02032x - .000416 \times 2$ |
| Reinhard, Schindler, Raabe, Stahlberg, and Messner (2014) | 2/3/5/7 | 276 | — | 2 | 5 | — | — | 9 | 2 | 2 | $y = .24212 + .26329x - .029635 \times 2$ |
| Reinhard, Schindler, Raabe, Stahlberg, and Messner (2014) | 2/3/5/7 | 276 | — | 2 | 5 | — | — | 9 | 2 | 2 | $y = .56054 + .18472x - .020114 \times 2$ |
| Rethans, Swasy, and Marks (1986) | 1/3/5 | 65 | — | — | 9 | — | 30 | 5 | 2 | 2 | $y = .63270 + .13583x - .016875 \times 2$ |
| Rethans, Swasy, and Marks (1986) | 1/3/5 | 65 | — | — | 9 | — | 90 | 5 | 2 | 2 | $y = .82333 + .06916x - .012500 \times 2$ |
| Rolison and Edworthy (2012) | 1/2/3/4/5/6 | 57 | 18 | — | 1 | — | 191 | 5 | 1 | 2 | $y = .51435 - .02112x + .002217 \times 2$ |
| Saegert and Jellison (1970) | 0/1/2/5/10/25 | 59 | 86 | 2 | 2 | — | 3 | 1 | 2 | 2 | $y = .61362 + .01233x - .000495 \times 2$ |
| Saegert and Jellison (1970) | 0/1/2/5/10/25 | 59 | 86 | 2 | 2 | — | 3 | 1 | 2 | 2 | $y = .67185 + .01092x - .000247 \times 2$ |
| Saegert and Jellison (1970) | 0/1/2/5/10/25 | 59 | 86 | 2 | 2 | — | 3 | 6 | 2 | 2 | $y = .60932 + .00541x - .000158 \times 2$ |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Saegert and Jellison (1970) | 0/1/2/5/10/25 | 59 | 86 | 2 | 2 | — | 3 | 6 | 2 | 2 | $y = .60746 + .00896x - .000234 \times 2$ |
| Schellenberg, Peretz, and Vieillard (2008) | 0/2/8/32 | 54 | 84 | 2 | 1 | 1 | 14.5 | 1 | 2 | 2 | $y = .72598 - .00031x - .000113 \times 2$ |
| Schellenberg, Peretz, and Vieillard (2008) | 0/2/8/32 | 54 | 84 | 2 | 1 | 1 | 14.5 | 1 | 2 | 2 | $y = .68764 + .00320x - .000047 \times 2$ |
| Schellenberg, Peretz, and Vieillard (2008) | 0/1/2/8/32 | 54 | 84 | 2 | 1 | 1 | 14.5 | 6 | 2 | 2 | $y = .36823 + .12904x - .003266 \times 2$ |
| Schellenberg, Peretz, and Vieillard (2008) | 0/1/2/8/32 | 54 | 84 | 2 | 1 | 1 | 14.5 | 6 | 2 | 2 | $y = .59318 + .03735x - .000884 \times 2$ |
| Schumann, Petty, and Clemons (1990) | 1/4/8 | 150 | — | 2 | 5 | — | 23 | 1 | 2 | 2 | $y = .82791 - .06468x + .005520 \times 2$ |
| Schumann, Petty, and Clemons (1990) | 1/4/8 | 100 | — | 2 | 5 | — | 23 | 10 | 2 | 2 | $y = .56601 + .07946x - .007976 \times 2$ |
| Singh and Cole (1993) | 1/4/8 | 23 | 20 | 2 | 9 | — | 15 | 1 | 2 | 2 | $y = .74119 - .03607x + .003214 \times 2$ |
| Singh and Cole (1993) | 1/4/8 | 23 | 20 | 2 | 9 | — | 30 | 1 | 2 | 2 | $y = .62301 + .01845x - .003134 \times 2$ |
| Smith and Dorfman (1975) | 1/5/10/20 | 100 | 36 | 2 | 4 | 2 | 3 | 1 | 2 | 2 | $y = .77532 - .02067x + .000810 \times 2$ |
| Smith and Dorfman (1975) | 1/5/10/20 | 100 | 36 | 2 | 4 | 2 | 3 | 5 | 2 | 2 | $y = .78017 - .00682x + .000063 \times 2$ |
| Smith and Dorfman (1975) | 1/5/10/20 | 100 | 36 | 2 | 4 | 2 | 3 | 5 | 2 | 2 | $y = .57620 + .01935x - .000519 \times 2$ |
| Standing and Thompson (1990) | 0/1/2/5/10/25 | 36 | 86 | 2 | 4 | — | 2 | 1 | 2 | 2 | $y = .67703 - .00789x + .000323 \times 2$ |
| Standing and Thompson (1990) | 0/1/2/5/10/25 | 36 | 86 | 2 | 4 | — | 2 | 1 | 2 | 2 | $y = .64611 + .00810x - .000320 \times 2$ |
| Standing and Thompson (1990) | 0/1/2/5/10/25 | 36 | 86 | 2 | 4 | — | 2 | 1 | 2 | 2 | $y = .63666 + .00709x - .000209 \times 2$ |
| Standing and Thompson (1990) | 0/1/2/5/10/25 | 36 | 86 | 2 | 4 | — | 2 | 7 | 2 | 2 | $y = .71664 - .01070x + .000477 \times 2$ |
| Stang (1975) | 1/2/5/10/25/50 | 34 | 186 | 2 | 4 | .1 | 2 | 8 | 2 | 2 | $y = .68774 + .00334x - .000056 \times 2$ |
| Stang (1975) | 1/2/5/10/25/50 | 34 | 186 | 1 | 4 | .1 | 2 | 3 | 1 | 2 | $y = .69795 + .00217x - .000071 \times 2$ |
| Stang (1975) | 1/2/5/10/25/50 | 55 | 93 | 2 | 4 | .1 | 2 | 3 | 2 | 2 | $y = .68572 + .00047x - .000018 \times 2$ |
| Stang and O'Connell (1974), Study 1 | 1/2/5/10/25/50 | 55 | 93 | 1 | 4 | .1 | 2 | 3 | 1 | 2 | $y = .68128 + .00291x - .000081 \times 2$ |
| Stang and O'Connell (1974), Study 1 | 1/2/5/10/25/50 | 26 | 93 | 2 | 4 | .1 | 2 | 1 | 2 | 2 | $y = .73281 - .00059x - .000017 \times 2$ |
| Stang and O'Connell (1974), Study 2 | 1/2/5/10/25/50 | 26 | 93 | 1 | 4 | .1 | 2 | 1 | 1 | 2 | $y = .64871 + .01176x - .000234 \times 2$ |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stang and O'Connell (1974), Study 2 | 1/2/5/10/25/50 | 46 | 93 | 2 | 3 | .1 | 2 | 7 | 2 | 2 | $y = .71878 - .00137x + .000019 \times 2$ |
| Stang and O'Connell (1974), Study 3 | 1/2/5/10/25/50 | 46 | 93 | 1 | 3 | .1 | 2 | 1 | 1 | 2 | $y = .70741 + .00087x - .000075 \times 2$ |
| Stang and O'Connell (1974), Study 3 | 1/4/16/64 | 46 | 85 | 1 | 3 | — | 1 | 4 | 2 | 2 | $y = .83509 - .00080x + .000012 \times 2$ |
| Stang and O'Connell (1974), Study 4 | 1/4/16/64 | 46 | 85 | 1 | 3 | — | 1 | 1 | 3 | 2 | $y = .80681 + .00244x - .000024 \times 2$ |
| Stang and O'Connell (1974), Study 4 | 1/4/16/64 | 46 | 85 | 1 | 3 | — | 1 | 3 | 3 | 2 | $y = .79461 + .00278x - .000026 \times 2$ |
| Stuart, Shimp, and Engle (1987) | 1/3/10/20 | 24 | — | 2 | 5 | — | 5 | 3 | 2 | 2 | $y = .57363 - .00409x + .000084 \times 2$ |
| Suedfeld, Epstein, Buchanan, and Landon (1971) | 0/1/2/5/10/25 | 72 | 43 | 2 | 2 | — | 2 | 3 | 2 | 2 | $y = .65802 + .01842x - .000450 \times 2$ |
| Suedfeld, Epstein, Buchanan, and Landon (1971) | 0/1/2/5/10/25 | 72 | 43 | 2 | 2 | — | 2 | 3 | 2 | 2 | $y = .57619 + .01878x - .000880 \times 2$ |
| Szpunar, Schellenberg, and Pliner (2004), Study 1 | 0/4/16/64 | 30 | 168 | 2 | 1 | .3 | 15 | 3 | 1 | 2 | $y = .63746 - .00078x + .000011 \times 2$ |
| Szpunar, Schellenberg, and Pliner (2004), Study 1 | 0/4/16/64 | 20 | 168 | 2 | 1 | .3 | 15 | 3 | 2 | 2 | $y = .57793 + .00596x - .000071 \times 2$ |
| Szpunar, Schellenberg, and Pliner (2004), Study 1 | 0/1/4/16/64 | 30 | 168 | 2 | 1 | .3 | 15 | 1 | 1 | 2 | $y = .39345 + .05659x - .000704 \times 2$ |
| Szpunar, Schellenberg, and Pliner (2004), Study 1 | 0/1/4/16/64 | 20 | 168 | 2 | 1 | .3 | 15 | 1 | 2 | 2 | $y = .64337 + .00349x - .000048 \times 2$ |
| Szpunar, Schellenberg, and Pliner (2004), Study 2 | 0/2/8/32 | 20 | 84 | 2 | 1 | .5 | 15 | 1 | 1 | 2 | $y = .61575 + .02422x - .000821 \times 2$ |
| Szpunar, Schellenberg, and Pliner (2004), Study 2 | 0/2/8/32 | 20 | 84 | 2 | 1 | .5 | 15 | 1 | 2 | 2 | $y = .61747 + .02148x - .000493 \times 2$ |
| Szpunar, Schellenberg, and Pliner (2004), Study 2 | 0/1/2/8/32 | 20 | 84 | 2 | 1 | .5 | 15 | 1 | 1 | 2 | $y = .36439 + .12363x - .003115 \times 2$ |
| Szpunar, Schellenberg, and Pliner (2004), Study 2 | 0/1/2/8/32 | 20 | 84 | 2 | 1 | .5 | 15 | 1 | 2 | 2 | $y = .69671 + .02324x - .000609 \times 2$ |
| Szpunar, Schellenberg, and Pliner (2004), Study 3 | 0/4/16/64 | 30 | 84 | 2 | 1 | 1 | — | 1 | 1 | 2 | $y = .60357 + .00472x - .000078 \times 2$ |
| Szpunar, Schellenberg, and Pliner (2004), Study 3 | 0/4/16/64 | 30 | 84 | 2 | 1 | 1 | — | 1 | 2 | 2 | $y = .60460 + .00390x - .000029 \times 2$ |
| Szpunar, Schellenberg, and Pliner (2004), Study 3 | 0/1/4/16/64 | 30 | 84 | 2 | 1 | 1 | — | 1 | 1 | 2 | $y = .46032 + .05492x - .000702 \times 2$ |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Szpunar, Schellenberg, and Pliner (2004), Study 3 | 0/1/4/16/64 | 30 | 84 | 2 | 1 | 1 | — | 1 | 2 | 2 | y = .61241 + .01346x − .000177 × 2 |
| Tan, Spackman, and Peaslee (2006) | 1/2/3/4 | 74 | 56 | 2 | 1 | 20 | 60 | 1 | 1 | 2 | y = .57625 + .03746x − .004821 × 2 |
| Tan, Spackman, and Peaslee (2006) | 1/2/3/4 | 74 | 56 | 2 | 1 | 20 | 60 | 1 | 1 | 2 | y = .45678 + .04150x − .003928 × 2 |
| Topolinski and Strack (2009) | 0/1/2/5/10/25 | 47 | 132 | 2 | 3 | 1 | — | 1 | 3 | 2 | y = .42585 + .01516x − .000339 × 2 |
| Tucker and Ware (1971) | 0/1/2/5/10/25 | 96 | 43 | 2 | 3 | — | 2 | 1 | 2 | 2 | y = .50535 + .04540x − .001180 × 2 |
| Van den Bergh and Vrana (1998) | 0/3/9/27 | 62 | 86 | 2 | 3 | — | — | 1 | 2 | 1 | y = .68000 + .00865x − .000385 × 2 |
| Van den Bergh and Vrana (1998) | 0/3/9/27 | 62 | 156 | 2 | 3 | — | — | 1 | 2 | 1 | y = .66238 + .00898x − .000213 × 2 |
| Van den Bergh and Vrana (1998) | 0/3/9/27 | 62 | 234 | 2 | 3 | — | — | 3 | 2 | 1 | y = .61569 + .01801x − .000507 × 2 |
| Vanbeseleare (1974), Study 1 | 0/1/2/5/10/25 | 24 | 43 | 2 | 3 | — | 2.5 | 5 | 2 | 2 | y = .65807 − .00266x + .000173 × 2 |
| Vanbeseleare (1974), Study 2 | 0/1/2/5/10/25 | 24 | 43 | 2 | 3 | — | 2.5 | 1 | 2 | 2 | y = .62479 − .00258x + .000285 × 2 |
| Vanbeseleare (1974), Study 3 | 0/1/2/5/10/25 | 24 | 43 | 2 | 3 | — | 2.5 | 5 | 2 | 2 | y = .68481 − .01146x + .000369 × 2 |
| Vanbeseleare (1977) | 0/1/2/5/10/25 | 90 | 43 | 2 | 3 | — | 3 | 1 | 2 | 2 | y = .64280 − .01119x + .000479 × 2 |
| Vanbeseleare (1977) | 0/1/2/5/10/25 | 90 | 43 | 2 | 3 | — | 3 | 1 | 2 | 2 | y = .58645 + .00315x + .000019 × 2 |
| Vanbeselaeare (1977) | 0/1/2/5/10/25 | 90 | 43 | 2 | 3 | — | 3 | 1 | 2 | 2 | y = .59206 + .00343x + .000124 × 2 |
| Wiggs (1993), Study 3 | 0/1/3/9 | 16 | 83 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | y = .69019 + .05543x − .004503 × 2 |
| Wiggs (1993), Study 3 | 0/1/3/9 | 16 | 83 | 2 | 2 | 2 | 2 | 1 | 2 | 3 | y = .69259 + .04325x − .003564 × 2 |
| Wiggs (1993), Study 3 | 0/1/3/9 | 16 | 83 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | y = .50353 + .18865x − .014835 × 2 |
| Wiggs (1993), Study 3 | 0/1/3/9 | 16 | 83 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | y = .56572 + .13154x − .012340 × 2 |
| Williams (1987) | 0/1/2/4/8/16/32/64/128 | 72 | 247 | 1 | 10 | .5 | 1 | 1 | 2 | 2 | y = .64477 + .00071x − .000008 × 2 |
| Wong (2015) | 1/2/5/10/20 | 32 | 60 | 2 | 5 | 3 | 2 | 7 | 2 | 2 | y = .44701 − .00150x + .000041 × 2 |
| Wong (2015) | 1/2/5/10/20 | 32 | 60 | 2 | 5 | 3 | 2 | 7 | 2 | 2 | y = .38684 + .00808x − .000247 × 2 |
| Zajonc (1968), Study 1 | 0/1/2/5/10/25 | 36 | 86 | 2 | 2 | — | 2 | 5 | 2 | 2 | y = .62964 + .01639x − .000399 × 2 |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Zajonc (1968), Study 1 | 0/1/2/5/10/25 | 36 | 86 | 2 | 3 | — | 2 | 5 | 2 | 2 | y = .62161 + .01668x − .000437 × 2 |
| Zajonc (1968), Study 3 | 0/1/2/5/10/25 | 30 | 86 | 2 | 5 | — | 2 | 7 | 2 | 2 | y = .62405 + .01782x − .000475 × 2 |
| Zajonc, Crandall, Kail, and Swap (1974), Study 1 | 0/1/9/27/243 | 36 | 280 | 2 | 2 | — | .17 | 1 | 2 | 2 | y = .72740 + .00073x − .000004 × 2 |
| Zajonc, Crandall, Kail, and Swap (1974), Study 1 | 0/1/9/27/243 | 36 | 280 | 2 | 2 | — | .17 | 1 | 2 | 2 | y = .59874 + .00248x − .000004 × 2 |
| Zajonc, Crandall, Kail, and Swap (1974), Study 2 | 0/1/9/27/243 | 20 | 280 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | y = .69631 − .00360x + .000018 × 2 |
| Zajonc, Crandall, Kail, and Swap (1974), Study 2 | 0/1/9/27/243 | 20 | 280 | 2 | 2 | 2 | 1 | 3 | 2 | 2 | y = .69475 + .00611x − .000027 × 2 |
| Zajonc, Shaver, Tavris, and Van Kreveld (1972), Study 3 | 0/1/2/5/10/25 | 36 | 86 | 2 | 5 | .5 | 2 | 3 | 2 | 2 | y = .62891 + .01502x − .000379 × 2 |
| Zajonc, Shaver, Tavris, and Van Kreveld (1972), Study 3 | 0/1/2/5/10/25 | 18 | 86 | 2 | 4 | .5 | 2 | 4 | 2 | 2 | y = .56243 − .00478x + .000008 × 2 |
| Zajonc, Shaver, Tavris, and Van Kreveld (1972), Study 3 | 0/1/2/5/10/25 | 36 | 86 | 2 | 5 | .5 | 2 | 3 | 2 | 2 | y = .66220 + .01544x − .000424 × 2 |
| Zajonc, Shaver, Tavris, and Van Kreveld (1972), Study 3 | 0/1/2/5/10/25 | 18 | 86 | 2 | 4 | .5 | 2 | 1 | 2 | 2 | y = .48790 + .01261x − .000445 × 2 |
| Zajonc, Shaver, Tavris, and Van Kreveld (1972), Study 4 | 2/5/10/25 | 32 | 84 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | y = .50752 + .00089x + .000105 × 2 |
| Zajonc, Shaver, Tavris, and Van Kreveld (1972), Study 4 | 2/5/10/25 | 32 | 84 | 2 | 3 | 2 | 3 | 1 | 3 | 2 | y = .40869 + .02567x − .000763 × 2 |
| Zajonc, Shaver, Tavris, and Van Kreveld (1972), Study 4 | 2/5/10/25 | 32 | 84 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | y = .35731 + .02060x − .000299 × 2 |
| Zajonc, Shaver, Tavris, and Van Kreveld (1972), Study 4 | 2/5/10/25 | 32 | 84 | 2 | 3 | 2 | 3 | 1 | 3 | 2 | y = .41578 + .01930x − .000368 × 2 |
| Zajonc, Swap, Harrison, and Roberts (1971), Study 1 | 0/3/9/27/81 | 30 | 240 | 2 | 2 | .5 | 4 | 1 | 2 | 2 | y = .61641 + .00669x − .000052 × 2 |
| Zajonc, Swap, Harrison, and Roberts (1971), Study 2 | 0/1/3/9 | 24 | 240 | 2 | 2 | .5 | 4 | 3 | 2 | 2 | y = .59235 + .03308x − .001093 × 2 |

(*Appendix continues*)

| Study | Exposure conditions | *N* | Total stimuli | Presentation type | Stimulus type | ISI time | Exposure duration | Measure type | Delay | Age | Equation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Zajonc, Swap, Harrison, and Roberts (1971), Study 2 | 0/1/3/9/27 | 30 | 240 | 2 | 2 | .5 | 4 | 1 | 2 | 2 | y = .62174 + .01850x − .000486 × 2 |
| Zajonc, Swap, Harrison, and Roberts (1971), Study 3 | 1/3/9/27 | 48 | 83 | 2 | 2 | 4 | 4 | 1 | 2 | 2 | y = .67385 + .00137x − .000033 × 2 |

*Note.* Exposure condition presents the different levels of exposure. ISI = interstimulus interval; Presentation type (1 = heterogeneous; 2 = homogeneous); Stimulus type (1 = auditory, music; 2 = ideograph; 3 = nonsense word/syllable; 4 = painting/drawing/matrices; 5 = photograph; 6 = meaningful words; 7 = polygons; 8 = real person/object; 9 = auditory, nonmusic; 10 = other). Measure type (1 = liking; 2 = "goodness of meaning;" 3 = pleasing, appealing, pleasantness; 4 = "correctness" or "goodness;" 5 = recognition; 6 = prototypicality; 7 = other; 8 = negative affect; 9 = truth; 10 = familiarity); Delay (1 = immediate after the initial presentation; 2 = all stimuli presented then rated; 3 = all stimuli presented then delay before rating; 4 = naturalistic). Age (0 = children < 10 years; 1 = youth, 10–17 years; 2 = college age; 3 = older than college). Equation includes the quadratic equation that describes the effect.

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