Relational integrativity of prime-target pairs moderates congruity effects in evaluative priming

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Abstract In evaluative priming, positive or negative primes facilitate reactions to targets that share the same valence. While this effect is commonly explained as reflecting invariant structures in semantic long-term memory or in the sensorimotor system, the present research highlights the role of integrativity in evaluative priming. Integrativity refers to the ease of integrating two concepts into a new meaningful compound representation. In extended material tests using paired comparisons from two pools of positive and negative words, we show that evaluative congruity is highly correlated with integrativity. Therefore, in most priming studies, congruity and integrativity are strongly confounded. When both aspects are disentangled by manipulating congruity and integrativity orthogonally, three priming experiments show that evaluative-priming effects were confined to integrative prime-target pairs. No facilitation of prime-congruent targets was obtained for non-integrative stimuli. These findings are discussed from a broader perspective on priming conceived as flexible, context-dependent, and serving a generative adaptation function.

Keywords Evaluative priming · Affective priming · Relational integration · Integrativity · Semantic priming

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Introduction

In the evaluative priming (EP) paradigm (Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Herring et al., 2013), target stimuli have to be classified as fast as possible as either positive or negative. The typical EP effect is that on congruent trials, when targets are preceded by primes of the same valence, evaluative decisions are faster and, given a sizeable error rate, also more accurate than on incongruent trials, when prime and target are of opposite valence.

EP is a special instance of category priming. For EP effects, it is sufficient that prime and target fall into the same valence category, regardless of other aspects of semantic similarity and denotative meaning. For instance, “sunshine” and “altruistic” are semantically quite distant from each other, just as “murder” and “boring”, but the two pairs share a single semantic attribute, namely positive or negative valence, respectively. By focussing on valence as the most preeminent attribute (Osgood, Suci, & Tannenbaum, 1957) while disregarding many other attributes that affect the distance of stimulus meaning in semantic space, EP is a special instance of semantic priming. EP divides the world into two very broad semantic categories, contrasting everything we like, agree with, or approve against everything we dislike, disagree with, or disapprove, abstracting from other semantic attributes.

Thus, the domain of EP is enormous. Every valenced prime is supposed to have the potential to facilitate responses to virtually all evaluatively congruent targets. There is no restriction in the domain of the basic congruity principle, as evident in the assumption that EP is generally applicable for implicit measurement of virtually all attitudes (Fazio, 2001; Wittenbrink & Schwarz 2007). Without any restriction of the valence domain, it is assumed that positive or negative attitude objects have the potential, when used as a prime in an EP task, to facilitate responses to valence-congruent targets. The degree of facilitation over multiple valenced targets is used as a

quantitative (implicit) measure of the attitude toward the prime.

To be sure, this universal assumption holds at the functional level of analysis; it only says that EP applies valence-congruent stimulus pairs, regardless of the cognitive process (spreading activation or response facilitation) that accounts for the congruity effect at the mechanistic level. In any case, the term “evaluative priming” refers to a priming effect that is only constrained by valence, not by other more restrictive semantic attributes.

It may not be too surprising that this very broad notion of EP is not supported by a growing body of evidence pointing to manifold moderators and limiting conditions such as: Stimulus onset asynchrony [SOA] (De Houwer, Hermans, & Eelen, 1998), prime extremity (Glaser & Banaji 1999), or stimulus context (Klauer, Rossnagel, & Musch, 1997). The present research constitutes an attempt to understand the various limiting conditions and to restrict the domain of EP in a theoretically reasonable way by implementing the concept of relational integrativity (Estes & Jones, 2009). Integrativity refers to the extent to which a concept (e.g., a prime) can be combined with a second concept (i.e., a target), thereby generating a distinct new compound meaning. As evaluative congruency and integrativity are typically confounded in EP – in that integrative pairs are much more likely congruent than incongruent – the aim of the present research is to demonstrate that EP is at least partially due to integrativity. Across three experiments, we show that EP effects are largely confined to integrative stimulus pairs.

Theoretical accounts of evaluative priming (EP)

Classical accounts Consistent with the initial claim of EP as a universal and automatic effect, classical theoretical accounts refer to invariant structural causes, attributing EP either to associative proximity of congruent stimuli in semantic long-term memory or to enhanced compatibility or matching of motor (submotor or motivational-affective) responses elicited by congruent stimuli (Fazio et al., 1986; Hermans, Van den Broeck, & Eelen, 1998; Klinger, Burton & Pitts, 2000; Scherer & Lambert, 2009).¹

Note that both long-term associative memory and response compatibility imply invariant structural advantages for congruent prime-target pairs. As it is impossible to organize associative structures such that incongruent relations are closer to each other than congruent relations, spreading activation theories predict a robust and pervasive congruity effect. The notion of response compatibility is also bound to a universal congruity effect; it invariably predicts that submotor impulses elicited by the prime

facilitate a congruent (rather than an incongruent) response to the target. In either case, to explain incongruity effects (Fiedler, Bluemke, & Unkelbach, 2011; Glaser & Banaji, 1999; Herring et al., 2013), one has to postulate additional processes, such as post-lexical consistency checks or meta-cognitive correction.

Such auxiliary ad-hoc accounts of absent or reversed EP effects remain dissatisfactory, however, as long as there is no cogent evidence for an isolated correction process. Consider the following list of strong moderators. The congruity advantage has been shown to disappear or to be reversed (a) when the time interval between prime onset and target onset (SOA) is relatively long (Hermans, Spruyt, & Eelen, 2003); (b) when stimulus words are common rather than rare (Chan, Ybarra & Schwarz, 2006); (c) when participants are in negative mood states (Storbeck & Clore, 2008); (d) when most prime-target transitions in the stimulus list are incongruent (Fiedler et al., 2011; Klauer, Rossnagel, & Musch, 1997; Spruyt, Hermans, De Houwer, Vandromme, & Eelen, 2007); (e) when participants actively respond to primes rather than only to targets (Fiedler et al., 2011); (f) when uncertainty about the location of a target is reduced (Musch & Klauer, 2001), or (g) when attention is oriented towards nonaffective stimulus features (Spruyt, De Houwer, Hermans, & Eelen, 2007; Spruyt, De Houwer, & Hermans, 2009). Why should the mind attenuate or correct for an upcoming prime influence exactly under these conditions? Why should it be adaptive to cease following an environmental signal when SOA lasts a second, when a frequently used stimulus word appears, when in a negative mood, when reacting to the prime, when the stimulus list includes few congruent pairs, when the prime location is clearly defined, or when non-affective features are the focus of attention?

Alternative accounts Rather than reflecting corrections of fixed associations in long-term memory or motor pathways, all these priming failures and reversals may reflect flexible processes in working memory (Estes & Jones, 2009; Fiedler et al., 2011; Ratcliff & McKoon, 1988). From this perspective, priming conceived as a malleable adaptive process is sensitive to flexible online inferences about task structure and stimulus context. Primes may be discounted and functionally separated from targets, rather than assimilated, when the time interval (SOA) is long, when extra reactions or stimuli separate primes from targets, or when negative mood inhibits assimilative mental operations (Fiedler & Hütter, 2013; Storbeck & Clore, 2008). This rationale is also well in line with the psychophysical account by Klauer, Teige-Mocigemba, and Spruyt (2009), which assumes that activation of positive and negative valence is accumulated in separate nodes or counters. In order to evaluate a stimulus, the decision-maker accesses the recent change of these counters within a specific time window. Depending on the dynamic adjustments of this evaluation window used to judge a target, this can lead to assimilation or contrast effects. Assimilation occurs when primes are included in the evaluation window and contrast

¹ This is the case of still another account, the affective matching model (Klauer & Stern, 1992; Wentura, 2000), which describes a post-lexical mechanism where stimuli are compared for their evaluative consistency. An evaluative inconsistency facilitates affirmative responses whereas an evaluative inconsistency facilitates negative responses. Thus, this model predicts a congruity advantage specifically in tasks requiring affirmative/negative responses.

effects occur when primes have contributed to the initial counter states but no longer drive changes in these counters inside the evaluation window.

Such adjustments and inferences are also tailored to the current stimulus context. For example, given a list context within which most primes precede targets of opposite valence, adaptive inferences may facilitate responses to incongruent targets. Just as the utilization of perceptual cues is open to vicarious functioning (Brunswik, 1952), allowing for re-learning of specific cue functions as in Kohler's (1962) famous mirror-glass experiments, target evaluation may be conceived as a constructive process that allows for flexible prime utilization. Depending on whether prime-target pairs are encoded as integral or separable experiences, target evaluations may be biased (or not) toward primes.

Integrative priming One intriguing variant of such internally generated prime-target construal was recently pointed out by Estes and Jones (2009) for semantic priming. Drawing on Gagné's (2000) notion of relational integration, these authors demonstrated that noun pairs (such as “horse” – “doctor”) that bear little semantic overlap but solicit creative inferences of a new emergent compound (“a horse doctor”) lead to strong integrative priming effects. Participants showed faster responses in lexical decision tasks when the target could be more easily integrated with the prime. From a constructivist perspective, these findings make perfect sense because the very propensity of a noun pair to generate a compound is incompatible with the separation of the prime from the target. It rather facilitates a generative process of prime-target integration and assimilation (Alexopoulos, Fiedler, & Freytag, 2012).

Integrativity as a key to understanding EP

The aim of the present research is to study the role of integrative-priming in the EP paradigm. Previous research has already suggested that EP entails generative post-lexical inferences, like for example combining primes and targets into the interrogative construction “is (prime) (target)?” (e.g., “is death wise?”; Klauer & Stern, 1992; Wentura, 1999), but these precursors did not provide a direct test of the contribution of integrativity to this kind of plausibility check.

We believe that integrativity plays an even stronger role in EP than in semantic priming, because evaluative congruity places weaker constraints on prime-target pairs than semantic relatedness. Primes may only facilitate the evaluation of congruent targets when both can be integrated into a compound, rather than evaluative responses to all congruent targets. Thus, EP effects should be observed for integrative pairs like “shower – pleasant” but not for equally congruent but non-integrative pairs like “candle – funny.” If so, integrativity would greatly constrain the theoretical meaning of EP, reducing the phenomenon from a generalized congruity effect to a

more restrictive advantage for congruent integrative stimulus pairs. This would be also in line with the notion of a “fan effect” (Anderson & Bower, 1973), which implies that the impact of a single prime is unlikely to carry over to a gigantic fan of a thousand other valenced targets.

With respect to Maki and Buchanan's (2008) distinction of three types of association measures – semantic feature overlap, co-occurrence rates in stimulus environments and likelihood of generating a target stimulus from a cue in an association test – integrativity can be conceived as a relational function of the latter type. It reflects the readiness to generate an associative link between selected pairs of a cue (prime) and a target. Such integrative associations between selected pairs (but not between all valence-congruent pairs) are relatively independent of the other two types of association, based on feature overlap (i.e., the semantic proximity) and co-occurrence rate (in the empirical world). Although integrativity can itself be conceived as a specific semantic function, it is clearly distinct from distance in terms of feature overlap or co-occurrence rate (for a related discussion, see Estes & Jones, 2009). Thus, the semantic features of “shower” and “pleasant” show little overlap, and they rarely co-occur in text corpora. However, they have the semantic propensity to construe a meaningful and vividly experienced compound: “pleasant shower.”

Although integrativity is conceptually close to other relational constructs, it is by no means redundant. There are several empirical findings supporting the relative independence of integrativity and association measures. Recent work by Mather, Jones, and Estes (2014) showed that integrative priming effects are independent from similarity or co-occurrence. In two experiments they obtained robust integrative priming effects using a perceptual identification task (Experiment 1) and a Stroop color-naming task (Experiment 2) with word-pair stimuli (e.g., mushroom – soup) that were low in associative strength, similarity, or co-occurrence as indexed by various measures (association norms; similarity ratings; LSA cosines; Google hits). Thus, integrative priming can be empirically set apart from associative or semantic priming. Furthermore, in a systematic comparison of integrative, thematic (e.g., prescription – doctor), and taxonomic (e.g., nurse – doctor) relationships of word pairs taken from the Semantic Priming Project, Jones and Golonka (2012) reported a negative correlation between integrativity and taxonomic relatedness and no correlation between integrativity and thematic relatedness. These relations were further contrasted on additional measures of semantic richness (e.g., familiarity, similarity). It is noteworthy that integrativity was negatively correlated with feature similarity and measures of global co-occurrence but positively related to local co-occurrence and familiarity. Taken together, these findings support the idea that integrativity is a genuine and non-overlapping type of word pair relationship supporting a distinct type of priming based on a plausibility check (see Mather et al., 2014).

Thus, the integrativity perspective on EP would appear to be functionally plausible, because the ease of forming an integrative prime-target compound (cf. Gagné, 2000) can be expected to support the priming process. It is only natural that target evaluation relies on a prime that easily merges with the target in the course of inference making. Such integration ease should facilitate fast responding to congruent stimulus pairs (since the correct response is the same as that which would be adequate for the prime) but not to incongruent pairs, when ease and incongruency are in conflict. In contrast, an absence of such integration ease should reduce priming effects.

The notion that EP increases with integrativity is also consistent with the repeated demonstration that EP disappears when prime and target are functionally separated, granting that separation is the opposite of integration. For instance, EP effects decrease or disappear when responses are solicited between prime and target (Fiedler et al., 2011), or when the SOA between prime and target is long (De Houwer et al., 1998).

Integrativity can also account for the conspicuous asymmetry of EP effects. When all four combinations of positive and negative prime valence and positive and negative target valence are considered, the congruity advantage is mostly due to positive-positive pairs (Burghardt & Unkelbach, 2014; Fiedler et al., 2011; Unkelbach, Fiedler, Bayer, Stegmüller, & Danner, 2008). Facilitation for negative-negative trials is either weak or fully absent. This asymmetry may reflect that positive-positive pairs tend to be more integrative than negative-negative pairs. Empirical support for this testable assumption would not only provide a viable account for asymmetric EP effects, it would also be in line with the heightened density and interconnectedness of positive memory representations (Unkelbach et al., 2008) and with the repeated finding that positive affective valence facilitates generative mental activities (Fiedler, Nickel, Asbeck, & Pagel, 2003). Moreover, it would be consistent with the related observation that negative language is more precise and differentiated than positive language (Rozin, Berman, & Royzman, 2010). And this precision of negative language might reduce its priming potential.

Although congruity and integrativity bear a strong ecological correlation – integrative stimulus pairs are likely to share the same valence – it is possible to disentangle the two confounded variables. Both congruent pairs and incongruent stimulus pairs can be deliberately selected to be either integrative or non-integrative. Provided the integrativity of the word compounds can be shown to be independent of the valence of the composite words, which has to be partialled out, we can then test to what extent the typical EP effect (i.e., congruity, mostly for positive stimuli) is stronger for integrative than for non-integrative prime target pairs.

Preview of research and predictions

To test these considerations, we conducted three EP experiments varying integrativity in addition to prime valence and target valence. Both experiments employed the same task setting and procedure, but completely independent stimulus sets to enhance the generality of the integrativity effect. The aim was to test three ordered hypotheses: (1) In a large stimulus pool, congruent prime-target pairs are more integrative than incongruent pairs; (2) positive congruent pairs are more integrative than negative congruent pairs; and (3) EP effects are significantly reduced for low- compared to high-integrativity pairs.

Experiment 1

A pilot study served to select the stimulus materials for the main experiment, such that integrativity could be varied independently of evaluative congruity.

Method

Materials

Twenty students of Heidelberg University were recruited for a material testing study. Twenty positive and 20 negative nouns selected from the Berlin Affective Word List (Vö, Jacobs, & Conrad, 2006), and 20 positive and 20 negative adjectives taken from Hager, Mecklenbräuker, Möller, and Westermann (1985) and Möller and Hager (1991) served as stimuli.² Positive and negative stimuli were matched regarding evaluative extremity and word length. Each participant was presented with a random subset of 400 out of all $40 \times 40 = 1,600$ noun-adjective pairs. Participants rated on 21-point scales the ease with which two concepts could be meaningfully combined. The scale endpoints were labelled “absolutely incompatible” and “absolutely compatible.” For each stimulus pair, the noun was presented alone for 1,000 ms (top left of the screen center) before the adjective appeared (top right of the screen center). Another 1,000 ms later, the rating scale appeared. The next trial began after an inter-trial interval of 2,000 ms.

As expected, an item-based analysis showed the mean integrativity rating to be clearly higher for congruent ($M = 12.65$, $SD = 4.64$) than for incongruent pairs ($M = 8.19$, $SD = 4.02$), $t(1598) = 20.54$, $p < .001$. This finding supports the hypothesized relationship between integrativity and congruity

² To circumvent grammatical intricacies of noun pairs in the German language, we opted for a type of combination frequently used in priming research, namely, noun adjective pairs; regarding relational integrativity, nouns and adjectives are typically related to each other based on a concept-has-property-relation (e.g., combining the noun/prime “day” with the adjective/target “cold” might create the meaningful representation such as “a cold day”). All stimuli and their ratings can be found in the Appendix.

and naturally also shows up in a point biserial correlation (with congruity being dichotomous) of $r = .46$, $p < .001$.

Also as hypothesized, integrativity was asymmetrically more enhanced for positive congruent ($M = 14.30$, $SD = 4.55$) than for negative congruent ($M = 10.99$, $SD = 4.11$) pairs, $t(798) = 10.82$, $p < .001$, which tended in turn to be higher in integrativity than positive-negative pairs ($M = 8.55$, $SD = 4.07$), $t(798) = 8.44$, $p < .001$. Negative-positive pairs were even lower in integrativity ($M = 7.82$, $SD = 3.94$), $t(798) = 2.55$, $p = .01$, indicating that positive nouns are more easily linked syntagmatically to negative preceding adjectives than negative nouns to positive adjectives.

For the main study, eight pairs of primes (P) and targets (T) were selected for each combination of prime valence (P+ and P–), target valence (T+ and T–), and integrativity (high and low), such that congruent and incongruent pairs were matched for integrativity. This resulted in a total of 64 word pairs such as: “shower – pleasant” (P+T+, high), “nature – dirty” (P+T–, high), “gas – natural” (P–T+, high), “ammunition – loud” (P–T–, high); “cocoa – attractive” (P+T+, low), “book – loud” (P+T–, low), “corpse – pleasant” (P–T+, low), “ammunition – bleak” (P–T–, low).

For the highly integrative pairs, the ratings of congruent and incongruent pairs, respectively, were $M_{P+T+} = 19.76$, $M_{P–T–} = 18.65$ and $M_{P+T–} = 17.54$, $M_{P–T+} = 16.31$. For low-integrativity pairs, the corresponding means were $M_{P+T+} = 4.30$, $M_{P–T–} = 4.30$ for congruent and $M_{P+T–} = 3.20$, $M_{P–T+} = 2.90$ for incongruent pairs.³

Using the norm data provided by Vö, Jacobs, and Conrad (2006), we also made sure that valence did not vary across integrativity conditions. Average evaluations of primes were nearly identical for high and low integrativity with $M_{PosHigh} = 1.39$ versus $M_{PosLow} = 1.43$ for positive primes and $M_{NegHigh} = -1.54$ versus $M_{NegLow} = -1.52$ for negative primes.

Procedure of main experiment

Thirty-four students of the University of Heidelberg participated in small groups of up to six. One participant was excluded for being an outlier regarding his error rate ($>$ third quartile + $1.5 \times$ interquartile range). Participants were told that the purpose of the experiment was to measure the speed with which words can be classified as positive or negative. Each trial of an extended series would involve two words, of which the first appeared only briefly on the screen, whereas the second word would remain on-screen until participants had classified it as either positive or negative, using two response keys

(i.e., “y” and “–”, respectively, on a QWERTZ-German keyboard). Every trial started with a prime presented for 320 ms, followed by a blank screen for 130 ms and the presentation of a target (SOA = 450 ms). Participants were asked to evaluate the target as fast as possible. As soon as it was classified as positive or negative, the target was erased. During a 2,000-ms inter-trial interval, the screen remained blank. A fixation-cross presented for 1,000 ms in the middle of the screen signalled the start of the next trial. Each word pair was presented twice, yielding 128 trials.

Results and discussion

Mean latencies for correctly classified targets were computed within participants for P+T+, P+T–, P–T+, and P–T– trials. To reduce the influence of outlier responses, responses below 300 ms (0.3 % of trials) and responses above 1,500 ms (3.6 % of trials) were removed (for similar cut-off values, see Fockenberg, Koole, & Semin, 2008; Hermans, De Houwer, & Eelen, 1994, 2001). The data were still skewed and therefore normalized by applying a log transformation prior to averaging. Although the statistical analyses were based on the log data, the descriptive statistics are presented in terms of the natural ms scale (i.e., anti-log transformed summary statistics). Note that this log transformation did not moderate the results obtained in any experiment.

In a 2(prime valence) $\times$ 2(target valence) $\times$ 2(integrativity) ANOVA, a typical congruity effect is evident in a prime valence $\times$ target valence interaction, $F(1, 32) = 5.48$, $p = .03$, $\eta_p^2 = .146$. The left part of Fig. 1 illustrates this interaction and shows that when pooling across integrative and non-integrative trials, the congruity advantage (faster reaction times for congruent trials) is more pronounced for positive-positive pairs than for negative-negative pairs. A target valence main effect, $F(1, 32) = 4.14$, $p = .05$, $\eta_p^2 = .115$, is suggestive of a congruity advantage for positive targets. A main effect of integrativity, $F(1, 32) = 4.58$, $p = .04$, $\eta_p^2 = .125$, is indicative of faster responses for pairs high in integrativity.

The moderating impact of integrativity on evaluative priming is manifested in a three-way prime valence $\times$ target valence $\times$ integrativity interaction, $F(1, 32) = 8.15$, $p < .001$, $\eta_p^2 = .203$. Moreover, a significant prime valence $\times$ integrativity interaction, $F(1, 32) = 4.93$, $p = .03$, $\eta_p^2 = .134$, reflects an enhanced influence of integrativity on positive primes (cf. Fig. 1), consistent with the asymmetric concentration of EP on positive trials.⁴

³ For stimuli high in integrativity, these slight differences are reflected in a main effect of prime valence, $F(1, 28) = 4.46$, $p = .04$, $\eta_p^2 = .138$ and an interaction of prime valence $\times$ target valence, $F(1, 28) = 16.99$, $p < .001$, $\eta_p^2 = .378$. For low-integrative stimuli, there is only a marginally significant interaction of prime valence $\times$ target valence, $F(1, 28) = 3.60$, $p = .07$, $\eta_p^2 = .114$.

⁴ It should be noted that a standard ANOVA affords a conservative test of an asymmetric interaction that is mainly due to a facilitation effect for positive targets following positive primes. As a consequence, the strength of the basic congruity effect (i.e., the prime valence $\times$ target valence interaction) and of the higher-order interaction with integrativity is therefore underestimated; more appropriate contrast analyses would thus provide stronger interaction effects (Rosenthal & Rosnow, 1985). To avoid the problem of defining a theoretically appropriate contrast, though, we rely here on a conservative ANOVA test.

Fig. 1 Results from Experiment 1: mean reaction time (ms) as a function of prime valence, target valence, and integrativity. The left part shows the results pooled across all trials. The right part shows the results separately for high- and low-integrativity trials. Error bars show standard errors

The right part of Fig. 1 gives insight into the nature of this three-way interaction. While there is a strong evaluative priming effect for stimuli high in integrativity, there is no congruity advantage for low-integrative stimuli. Two separate ANOVAs for high-integrative and low-integrative trials support this interpretation. As predicted, only for high-integrativity pairs did a significant prime valence $\times$ target valence interaction emerge indicating a clear-cut EP congruity effect, $F(1, 32) = 11.86$, $p < .01$, $\eta_p^2 = .270$. In addition, a marginally significant effect of prime valence, $F(1, 32) = 3.27$, $p = .08$, $\eta_p^2 = .093$, points to a congruity advantage for positive stimuli. For low-integrativity pairs, the interaction effect was absent, $F < 1$, and only a marginally significant effect for target valence, $F(1, 32) = 3.91$, $p = .06$, $\eta_p^2 = .109$, emerged.

Given the use of fixed prime-target pairs, the findings are potentially sensitive to the language-as-fixed-effect fallacy (Clark, 1973). We therefore conducted an item analysis (F2 statistic) to assure generalizability to other stimuli. Importantly, when averaging across items instead of participants, the same critical three-way interaction emerged, $F(1, 56) = 4.04$, $p = .05$, $\eta_p^2 = .067$. To qualify this three-way interaction, we again conducted separate ANOVAs for stimuli high and low in integrativity. For high-integrativity pairs, a significant prime valence $\times$ target valence emerged, $F(1, 28) = 9.43$, $p < .01$, $\eta_p^2 = .252$. For low-integrativity pairs, this interaction was completely absent, $F < 1$.

Altogether, these findings demonstrate that in a design that disentangles congruity and integrativity, there is no longer a uniform valence-based congruity effect, corroborating a strong version of our third hypothesis: EP effects were reduced (to non-existence) for low- compared to high-integrative word pairs. The robustness of this phenomenon is now tested in the next experiment using a completely new stimulus sample. To anticipate, a final experiment will then address the possibility that a lack of power or too long SOAs may have qualified the reported results.

Experiment 2

For the sake of generalizability, the second experiment constitutes a replication with a completely new set of prime and target stimuli.

Method

Materials

Thirty students of Heidelberg University participated in a similar pilot study to Experiment 1. New sets of positive and negative nouns and adjectives (17 each) were selected (again controlling for evaluative extremity and word length) from Schwibbe, Räder, Schwibbe, Borchert, and Geiken-Pophanken (1981), yielding 1,156 noun-adjective pairs.

Again, mean integrativity ratings clearly distinguished between congruent ($M = 13.31$, $SD = 4.54$) and incongruent pairs ($M = 6.65$, $SD = 4.20$), $t(1154) = 25.91$, $p < .001$. The corresponding point biserial correlation between valence congruity (dichotomous) and mean integrativity amounts to $r = .61$, $p < .001$. Enhanced integrativity was again clearly stronger for positive congruent pairs ($M = 15.32$, $SD = 3.86$) than for negative congruent pairs ($M = 11.30$, $SD = 4.28$), $t(576) = 11.88$, $p < .001$. For incongruent pairs, the low integrativity was more extreme when negative primes preceded positive targets ($M = 5.00$, $SD = 3.35$) than when positive primes preceded negative targets ($M = 8.29$, $SD = 4.32$), $t(576) = 10.26$, $p < .001$.

Subsets of eight pairs were again selected for each combination of positive and negative primes and targets, separately for high and low integrativity, resulting in 64 different word pairs. Mean integrativity ratings of highly integrative pairs were again roughly equal for congruent, $M_{P+T+} = 16.92$, $M_{P-T-} = 15.20$, and incongruent pairs $M_{P+T-} = 16.86$, $M_{P-T+} = 14.80$. Likewise, for stimulus pairs low in integrativity, the mean ratings of congruent, $M_{P+T+} = 6.73$, $M_{P-T-} = 4.35$, and

Fig. 2 Results from Experiment 2: mean reaction time (ms) as a function of prime valence, target valence, and integrativity. The left part shows the results pooled across high-integrativity and low-integrativity trials. The

right part shows the results separately for high- and low-integrativity trials. Error bars indicate standard errors

incongruent pairs $M_{P+T-} = 5.12$, $M_{P-T+} = 4.42$, were comparable.⁵

Using the norms provided by Schwibbe et al. (1981), we again ensured that valence did not vary across integrativity conditions. Average evaluations of primes were nearly identical for high and low integrativity with $M_{PosHigh} = 5.08$ versus $M_{PosLow} = 5.03$ for positive primes and $M_{NegHigh} = 3.00$ versus $M_{NegLow} = 2.97$ for negative primes.

Main EP experiment

Sixty students of Heidelberg University participated in the study. Four participants were excluded for being outliers with regards to their error rate (>third quartile + 1.5* interquartile range). Except for the stimuli, the second experiment was in all details the same as the first EP experiment described above.

Results and discussion

The latency data were prepared in the same way as in Experiment 1 (2.0 % of trials were removed for being faster than 300 ms, 4.1 % of trials were removed for being slower than 1,500 ms). Data were again still skewed and therefore normalized by applying a log transformation prior to averaging. A 2(prime valence) × 2(target valence) × 2(integrativity) ANOVA produced a similar pattern as in the first experiment. As evident from Fig. 2, however, the asymmetry of the EP effect was even more pronounced. Although a significant prime valence × target valence interaction, $F(1, 56) = 9.52$, $p < .01$, $\eta_p^2 = .144$, indicates that responses were faster for

congruent than for incongruent trials, this congruity advantage was exclusively due to facilitation on trials involving positive primes and positive targets (cf. Fig. 2). As mean latencies were generally faster for positive primes and for positive targets, there were marked main effects for prime valence, $F(1, 56) = 22.06$, $p < .001$, $\eta_p^2 = .283$, and target valence, $F(1, 56) = 7.82$, $p < .01$, $\eta_p^2 = .123$. Most importantly, the three-way prime valence × target valence × integrativity interaction was again significant, $F(1, 56) = 7.66$, $p < .01$, $\eta_p^2 = .120$.

A separate ANOVA for high-integrative stimuli yielded a prime-valence main effect, $F(1, 56) = 18.62$, $p < .001$, $\eta_p^2 = .250$, a target-valence main effect, $F(1, 56) = 11.22$, $p < .01$, $\eta_p^2 = .167$, and the critical prime valence × target valence interaction, $F(1, 56) = 18.32$, $p < .001$, $\eta_p^2 = .247$. In contrast, when integrativity was low, only a prime valence main effect, $F(1, 56) = 10.07$, $p < .01$, $\eta_p^2 = .152$, and a marginally significant target valence main effect were obtained, $F(1, 56) = 3.02$, $p = .09$, $\eta_p^2 = .051$. The prime valence × target valence interaction (the statistical test of congruity) was negligible, $F < 1$.

To assure generalizability to other stimuli, we again conducted an item-analysis (F2 statistic). The three-way prime-valence × target valence × integrativity interaction was marginally significant, $F(1, 56) = 3.53$, $p = .07$, $\eta_p^2 = .059$. Two separate ANOVAs for stimuli high and low in integrativity revealed a marginally significant congruity effect in the form of a prime valence × target valence for stimuli high in integrativity, $F(1, 28) = 3.42$, $p = .08$, $\eta_p^2 = .109$ but no interaction for stimuli low in integrativity, $F < 1$.

Experiment 2 provided further evidence for the important role of integrativity in evaluative priming. Using a new set of stimuli, we again showed that when congruity and integrativity are disentangled, congruity effects are limited to high-integrative word pairs. However, one could argue that the SOA used in Experiments 1 and 2 was moderately long (i.e., 450 ms). Such a time window might have allowed

⁵ For high-integrative stimuli, the slight differences are reflected in a main effect for prime valence, $F(1, 28) = 5.28$, $p = .03$, $\eta_p^2 = .159$. For low-integrative stimuli, there is also a main effect of prime valence, $F(1, 28) = 5.39$, $p = .03$, $\eta_p^2 = .162$.

participants to engage in slow-acting, strategic processes which could somewhat strengthen the influence of integrativity. It is noteworthy that this argument is somewhat incompatible with Estes and Jones (2009) as well as Jones and Golonka (2012) who found that integrative priming is reduced or even eliminated, rather than enhanced, at longer SOAs. However, we wanted to rule out the possibility that our findings are simply due to a specific SOA value. We therefore ran a third experiment using a shorter SOA of 200 ms (Wentura & Degner, 2010).

Moreover, since one of our arguments relies on the reduction or non-appearance of an effect (the EP in the low integrativity condition), it is crucial to conduct well-powered experiments. In contrast to the relatively small sample size in Experiment 1, Experiment 3 uses a larger sample to ensure satisfying statistical power.⁶

Experiment 3

The third experiment constitutes a replication using the stimulus set of Experiment 1, but with a larger sample and a shorter SOA (200 ms).

Method

Materials

The same materials were used as in Experiment 1.

Main EP experiment

Eighty-one students of the University of Heidelberg participated in the study. One participant was excluded for being an outlier with regard to his error rate ($>$ third quartile + 1.5* interquartile range). In most parts, this third experiment was a conceptual replication of the first two priming experiments. This time, however, we used a shorter SOA of 200 ms. Every trial started with a fixation cross presented for 1,000 ms, followed by a prime presented for 200 ms, immediately overwritten by the target. As soon as the target was classified as either positive or

negative, it was erased. After a 2,000-ms inter-trial interval, the next trial began. Each word pair was presented twice, yielding a total of 128 experimental trials.

Results and discussion

Latency data was again prepared in the same way as in Experiments 1 and 2 (0.1 % trials removed for being $<$ 300 ms, 5.3 % of trials removed for being $>$ 1,500 ms).⁷ Again, data were normalized by applying a log transformation.

A 2(prime valence) $\times$ 2(target valence) $\times$ 2(integrativity) ANOVA produced a similar pattern to the first two experiments. Even though a significant prime valence $\times$ target valence interaction, $F(1, 79) = 34.53$, $p < .001$, $\eta_p^2 = .304$, indicates faster responses for congruent trials, this congruity advantage was again exclusively due to facilitation on trials involving positive primes and positive targets (cf. Fig. 3). Main effects of prime valence, $F(1, 79) = 10.08$, $p < .01$, $\eta_p^2 = .113$, and target valence, $F(1, 79) = 28.02$, $p < .001$, $\eta_p^2 = .262$, indicated faster responses after positive primes and positive targets. This time, a main effect of integrativity also emerged, $F(1, 79) = 15.23$, $p < .001$, $\eta_p^2 = .162$. Participants were generally faster in high- than low-integrative trials. There also was a marginal significant interaction of integrativity $\times$ prime valence, $F(1, 79) = 2.91$, $p = .09$, $\eta_p^2 = .036$, pointing to more valence asymmetries when integrativity was high. Most critically, the three-way interaction of prime valence $\times$ target valence $\times$ integrativity was replicated, $F(1, 79) = 20.65$, $p < .001$, $\eta_p^2 = .207$.

A separate ANOVA for high-integrative stimuli yielded a prime-valence main effect, $F(1, 79) = 9.75$, $p < .01$, $\eta_p^2 = .110$, a target-valence main effect, $F(1, 79) = 25.70$, $p < .001$, $\eta_p^2 = .245$, and the prime valence $\times$ target valence interaction, $F(1, 79) = 45.35$, $p < .001$, $\eta_p^2 = .365$. In contrast, for low integrativity, only a main effect of target valence reflected faster reactions to positive than negative targets, $F(1, 79) = 19.54$, $p < .001$, $\eta_p^2 = .198$. The prime valence $\times$ target valence interaction (testing for congruity effects) did not reach significance, $F(1, 79) = 1.39$, $p = .24$, $\eta_p^2 = .017$.

As in Experiments 1 and 2, we also conducted an item analysis (F2 statistic). The three-way interaction of prime valence $\times$ target valence $\times$ integrativity was again marginally significant, $F(1, 56) = 3.44$, $p = .07$, $\eta_p^2 = .058$. For stimuli high in integrativity, the congruity interaction of prime valence $\times$ target valence was highly significant, $F(1, 28) = 8.14$, $p < .001$, $\eta_p^2 = .225$, while it did not emerge for stimuli low in integrativity, $F < 1$.

⁶ We conducted a power analysis based on a meta-analysis by Herring et al. (2013) which samples many studies and therefore provides a more reliable estimation of the effect size than just our own experiments. For the evaluative decision task, Herring et al. (2013) computed an average effect size of $d = .45$. In a within-participants design, assuming an effect size of $d = .45$, a significance level of $\alpha = .05$, a target power of $1 - \beta = 0.8$, and a two-tailed test, an appropriate sample size would be $N = 41$. Experiment 1 ($N = 34$) was slightly below this estimation. However, assuming the parameters above, this experiment still had a power of .72. Experiment 2 ($N = 60$) provides a power of .92. In Experiment 3, we thus decided to sample 81 participants and this gave us a power of .98. This analysis suggests that there was sufficient power to detect an effect, given it is actually there.

⁷ Overall, participants in this experiment took generally longer to respond ($M = 761$ ms) than in the previous two experiments ($M = 667$ ms in Exp. 1, $M = 655$ ms in Exp. 2), presumably due to the shortened SOA (200 ms). Thus, the upper cutoff value of 1,500 ms might be too strict and exclude some valuable data. However, using a more lenient criterion of 2,135 ms (i.e., mean latency + 2.5 SDs; 1.8 % of trials removed) leads to an identical pattern of results.

Fig. 3 Results from Experiment 3: mean reaction time (ms) as a function of prime valence, target valence, and integrativity. The left part shows the results pooled across high-integrativity and low-integrativity trials. The

right part shows the results separately for high- and low-integrativity trials. Error bars indicate standard errors

General discussion

Overall, the findings obtained across all three experiments converged in a consistent pattern: An (asymmetric) congruity effect was only obtained under high integrativity. When integrativity was low, no congruity advantage was observed. The moderating role of integrativity was comparable across three evaluative priming experiments that varied the sets of verbal stimuli and SOAs. These clear-cut findings are perfectly in line with the integrative-priming results reported by Estes and Jones (2009) for semantic priming. They also challenge classic accounts of EP and provide support for the idea that relational integrativity of prime and target can facilitate target evaluation. The difference is that due to the nature of the EP task (classifying as positive or negative) our research was not about a main effect of integrativity, but about the potential of integrativity to potentiate evaluative congruency effects.

As predicted, then, the orthogonal variation of valence congruity and integrativity – two intrinsically confounded factors in EP experiments – lent support to integrativity as a crucial determinant of EP effects. Although the experiments yielded the typical (asymmetric) valence congruity effect that is commonly considered essential to EP, this was exclusively due to high-integrativity pairs. EP effects disappeared for low integrativity, although valence congruity was effectively manipulated in both subsets of prime-target pairs. It should be noted that it remains unclear whether the observed pattern of target reactions was due to facilitated processing of target words or a response-compatibility of prime-target responses. Most likely, it is a consequence of both (Fazio, 2001; Klauer, Musch, & Eder, 2005).

Because integrativity is normally confounded with valence congruity – most integrative pairs share the same valence – it is possible that apparent congruity effects in former EP studies may to an unknown degree reflect the impact of integrativity, which has never been controlled before. Future research will

have to test this possibility systematically, using both different verbal and non-verbal stimuli (e.g., images).

Although the present work does provide some evidence that these integrative priming effects are consistent over (relatively) short and moderate SOAs, looking at other presentation formats (subliminal durations; pictures instead of words) or paradigms (e.g., lexical decision or pronunciation tasks with an independent manipulation of congruity and integrativity) might also help gauging the scope of integrative priming effects. We do not feel justified to argue that relational integrativity as it is presented here is the only or the most important determinant of priming across all paradigms. Furthermore, the concept of integrativity might not be directly applicable to all implicit attitude procedures (e.g., when abstract stimuli are used as CSs and acquire their valence in an evaluative conditioning procedure), but a somewhat similar rationale could still apply. On a very general level, factors which facilitate joint encoding should strengthen the evaluative effects and factors which disrupt joint encoding should lead to weaker evaluative effects. Thus, granting that the various task settings allow two stimuli to be easily integrated (vs. not) into a meaningful compound, it could be the case that integrativity might play a role for other paradigms such as evaluative conditioning (De Houwer, Thomas, & Baeyens, 2001) or the affect misattribution procedure (AMP; Payne, Cheng, Govorun, & Stewart, 2005). For the time being, however, we showed that integrativity is indeed of great importance for evaluative priming.

Note that integrativity constitutes a more restrictive condition than valence congruity; faster responding on congruent trials is only observed for integrative pairs, not for non-integrative pairs. For facilitation to occur, congruent stimuli also have to be integrative. Moreover, the crucial condition for facilitation is further restricted by valence asymmetry. As visible from several analyses (Burghardt & Unkelbach, 2014; Fiedler et al., 2011), but concealed in many other studies that did not report results across all 2×2 trial types, EP facilitation is regularly stronger for

congruent-positive compared to congruent-negative trials. Taken together, this twofold restriction of EP to integrative and positive pairs may reflect the same critical factor, namely, the readiness to generate an integrative prime-target compound, which is neither determined by overlapping features in semantic memory (such as valence) nor by co-occurrence rate (Maki & Buchanan, 2008). This generative potential was indeed shown in the pilot study to be systematically higher for positive than for negative stimulus pairs. This is also in line with the well-established findings of enhanced creative associations, the construction of broader categories (Isen & Daubman, 1984), and the operation of top-down inferential processing (an *assimilative* processing mode, Fiedler, 2001) following positive situations or stimuli.

Such a propensity to generate compounds from positive stimuli is well in line with a growing body of evidence for the density model (Unkelbach et al., 2008), which implies shorter distances and more ramified connections between positive than negative stimuli. Further research may reveal, with respect to Maki and Buchanan's (2008) distinction of three largely independent measures of associations, that generative measures, rather than feature overlap or co-occurrence measures, are of most importance to the density model. Thus, the general finding that positive stimuli are more densely interconnected than negative ones does not appear to reflect stronger overlap of semantic features (as also noted by Estes & Jones, 2009) nor does it appear to reflect ecological occurrence rates. More plausibly, though, it reflects the same generative potential to create original links and compounds that was also shown here to determine the emergence and strength of EP effects. However, since an asymmetric congruity effect emerged even when controlling for integrativity (Experiment 2), the positivity effects seem to be at least partially independent of integrativity.

The evidence presented here calls for a revised perspective on EP. The basic congruity effect, which was initially assumed to reflect a robust principle (Fazio, 2001; Klauer & Musch, 2003), may actually not apply to all valence-congruent stimulus pairs. EP is an extreme version of categorical priming, based on the assumption that responses to all positive (vs. negative) targets will be facilitated after exposure to any positive (vs. negative) prime. Whereas previous EP research and theorizing did not explicitly reduce the domain of all stimuli sharing the same valence, it may not be too surprising that this assumption turns out to be unrealistic. Valence congruity is simply too broad and unrestricted a condition to render priming functional and informative. The present findings suggest that integrativity is a promising candidate for a more refined conception of valence congruity. When a prime and a target solicit the generation of a new compound, which goes beyond the old semantic attributes of the component stimuli, the vividly experienced valence of the compound seems to facilitate congruent evaluative reactions in target judgment tasks.

It could also be the case that reaction times were influenced by a response compatibility mechanism. Similar to the idea

behind the affective matching model (Wentura, 2000) the stimulus pairs might have imposed a yes/no question to the participants (e.g. “is prime target?” or “is this plausible?”). A “yes” response to such a question might map onto a “positive” response while a “no” response to such a question might map onto a “negative” response. Assuming that the integrative word pairs lead to such a “yes” response and non-integrative pairs lead to a “no” response, there is a possibility for conflicts to occur as a function of target valence and integrativity. For integrative pairs, positive targets should lead to an increase in speed and negative targets to a decrease. For non-integrative pairs, positive targets should lead to a decrease in speed and negative targets to an increase. In other words, there should be a target valence $\times$ integrativity interaction. However, we did not find such an interaction in any of our three experiments.

An open question is whether the notion of integrativity can be extended to nonverbal (e.g., pictorial) stimuli or prime-target pairs presented in different modalities (e.g., picture-word pairs). Would, for instance, positive or negative facial expressions, or film clips, only facilitate the evaluation of congruent trait words if they are applicable (cf. Higgins, Rholes, & Jones, 1977) to form an integrative impression? Would negative words trigger avoidance responses only when verbal primes are relevant to forming an avoidance compound (i.e., if the word valence qualifies the evaluative consequences of the stimulus person for the participant; cf. Wentura, Rothermund, & Bak, 2000)? Furthermore, we presented stimuli in a way which is typical for priming experiments: Nouns served as primes and adjectives served as targets. This setup might facilitate a specific type of relational integration (e.g., concept-has-property) and it remains an open question whether integrativity effects would be similar for different setups.

If future research lends further support to the proposed generative version of priming, involving the creation of new compounds rather than the retrieval of stored semantic attributes, this process should plausibly take place in working memory rather than in semantic long-term memory (e.g., Ratcliff & McKoon, 1988). However, whereas in the original compound-cue model the compound formation is dependent on the frequency of co-occurrence in texts and the strength of association at encoding, it is not necessarily the case within the present approach as integrative priming occurs for concepts which are not always associated or similar. Thus, the assumption of a universal, deterministic and inflexible process determined by long-term structures in the central or peripheral nervous system would have to be refined by a more flexible process that is subject to cognitive online activities and strategic exploitation of the stimulus context (Freitag, Bluemke, & Fiedler, 2011; Klauer et al, 2009).

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Appendix

Table 1 German prime words (nouns) and target words (adjectives) used for material tests in Experiments 1 and 3

German		English	
Primes	Targets	Primes	Targets
Positive stimuli			
Bett	angenehm	bed	Pleasant
Buch	attraktiv	book	Attractive
Diamant	beliebt	diamond	Popular
Dusche	echt	shower	Genuine
Eis	farbig	ice	Colored
Garten	flexibel	garden	Flexible
Herz	gemütlich	heart	Comfortable
Kakao	hübsch	cocoa	Pretty
Kamin	komisch	chimney	Comical
Kerze	kuschelig	candle	Cuddly
Küste	lustig	coast	Funny
Medaille	natürlich	medal	Natural
Milch	offen	milk	Open
Natur	originell	nature	Fancy
Oase	phantasievoll	oasis	Imaginative
Obst	phantastisch	fruit	Fantastic
Parfum	praktisch	perfume	Practical
Photo	schön	photo	Beautiful
Ring	toll	ring	Great
Sessel	wertvoll	armchair	Precious
Negative stimuli			
Abfall	altmodisch	waste	Oldfashioned
Bahre	bieder	bier	Respectable
Benzin	blass	gasoline	Pale
Blut	dick	blood	Corpulent
Dolch	dreckig	dagger	Filthy
Droge	düster	drug	Dark
Falle	ekelhaft	trap	Disgustful
Gas	eng	gas	Cramped
Gift	erschreckend	poison	Scary
Hagel	fett	hail	Fat
Horde	grob	horde	Rude
Keule	gruselig	club	Creepy
Knebel	hässlich	knob	Ugly
Leiche	langweilig	corpse	Boring
Makel	laut	flaw	Loud
Moder	öde	moldiness	Bleak
Munition	schmutzig	ammunition	Dirty
Rechnung	staubig	bill	Dusty
Unrat	stumpf	refuse	Dull
Urne	widerlich	urn	Disgusting

Table 2 Mean integrativity ratings of the stimulus pairs used in Experiments 1 and 3

German		English		M	SD
Prime	Target	Prime	Target		
High Integrativity					
Positive Prime/Positive Target					
Dusche	angenehm	shower	pleasant	21.00	0.00
Diamant	echt	diamond	genuine	21.00	0.00
Bett	gemütlich	bed	comfortable	20.60	1.26
Garten	schön	garden	beautiful	20.29	1.33
Parfum	attraktiv	perfume	attractive	20.22	1.99
Kerze	kuschelig	candle	cuddly	20.00	1.26
Eis	beliebt	ice	popular	19.00	3.23
Medaille	hübsch	medal	pretty	16.00	4.08
				19.76	1.64
Positive Prime/Negative Target					
Sessel	altmodisch	armchair	oldfashioned	19.83	1.17
Photo	hässlich	photo	ugly	19.50	2.81
Kamin	dreckig	chimney	dirty	19.00	2.59
Milch	fett	milk	fat	18.43	3.05
Buch	langweilig	book	boring	17.55	4.97
Natur	schmutzig	nature	dirty	15.69	5.15
Kakao	dick	cocoa	corpulent	15.50	6.36
Ring	bieder	ring	respectable	14.83	6.48
				17.54	4.07
Negative Prime/Positive Target					
Gas	natürlich	gas	natural	18.71	1.70
Leiche	echt	corpse	genuine	17.14	3.85
Droge	beliebt	drug	popular	17.00	5.48
Urne	wertvoll	urn	precious	16.10	5.63
Benzin	praktisch	gasoline	practical	16.09	3.78
Horde	lustig	horde	funny	16.00	5.06
Blut	farbig	blood	colored	15.00	4.08
Falle	phantasievoll	trap	imaginative	14.44	7.49
				16.31	4.63
Negative Prime/Negative Target					
Hagel	grob	hail	rude	20.40	0.89
Abfall	schmutzig	waste	dirty	19.40	3.50
Gift	widerlich	poison	disgusting	19.18	2.36
Munition	laut	ammunition	loud	18.89	2.89
Moder	gruselig	moldiness	creepy	18.88	3.00
Bahre	düster	bier	dark	18.43	2.23
Makel	hässlich	flaw	ugly	17.75	4.72
Unrat	staubig	refuse	dusty	16.30	6.41
				18.65	3.25
Low Integrativity					
Positive Prime/Positive Target					
Kerze	lustig	candle	funny	1.4	1.7
Milch	phantasievoll	milk	imaginative	3.4	5.4
Ring	kuschelig	ring	cuddly	3.5	5.0

Table 2 (continued)

German		English		M	SD
Prime	Target	Prime	Target		
Obst	flexibel	fruit	flexible	3.6	4.3
Kamin	komisch	chimney	comical	4.0	5.8
Dusche	originell	shower	fancy	4.8	5.1
Kakao	attraktiv	cocoa	attractive	6.5	5.4
Parfum	gemütlich	perfume	comfortable	6.9	4.9
				4.3	4.7
Positive Prime/Negative Target					
Eis	altmodisch	ice	oldfashioned	0.0	0.0
Herz	dreckig	heart	filthy	1.5	3.1
Garten	widerlich	garden	disgusting	1.9	2.7
Buch	laut	book	loud	3.8	4.1
Küste	dick	coast	corpulent	4.3	6.0
Oase	hässlich	oasis	ugly	4.6	5.8
Bett	düster	bed	dark	4.8	5.4
Sessel	erschreckend	armchair	creepy	5.0	5.8
				3.2	4.1
Negative Prime/Positive Target					
Urne	kuschelig	urn	cuddly	0.0	0.0
Leiche	angenehm	corpse	pleasant	0.3	0.5
Blut	attraktiv	blood	attractive	1.0	1.7
Dolch	gemütlich	dagger	comfortable	2.1	3.2
Falle	hübsch	trap	pretty	3.6	6.1
Knebel	phantastisch	knob	fantastic	4.2	3.7
Makel	offen	flaw	open	5.3	7.1
Horde	praktisch	horde	practical	6.5	5.6
				2.9	3.5
Negative Prime/Negative Target					
Unrat	fett	refuse	fat	3.2	0.8
Hagel	bieder	hail	respectable	3.5	5.3
Keule	eng	club	cramped	3.8	4.5
Bahre	laut	bier	loud	4.2	6.1
Gas	staubig	gas	dusty	4.2	4.3
Munition	öde	ammunition	bleak	4.5	3.7
Gift	grob	poison	rude	5.3	4.9
Benzin	stumpf	gasoline	dull	5.5	5.5
				4.3	4.4

Table 3 German prime words (nouns) and target words (adjectives) used for material tests in Experiment 2

German		English	
Primes	Targets	Primes	Targets
Positive stimuli			
Apfel	fair	apple	fair
Bild	freundlich	picture	friendly
Blick	fröhlich	view	cheerful
Blüte	gesund	bloom	healthy
Buch	glücklich	book	happy
Duft	herzlich	scent	cordial
Erdbeere	kreativ	strawberry	creative
Erde	lieb	earth	dear
Geschenk	lustig	present	funny
Getränk	natürlich	drink	natural
Kind	phantasievoll	child	imaginative
Kuss	sanft	kiss	gentle
Meer	schön	sea	beautiful
Strand	warm	beach	warm
Wald	witzig	forest	comical
Wiese	zart	meadow	delicate
Wohnung	zufrieden	apartment	content
Negative stimuli			
Abfall	arrogant	waste	arrogant
Bettler	blöde	beggar	stupid
Blut	bösartig	blood	vicious
Fabrik	brutal	factory	brutal
Gefängnis	destruktiv	prison	destructive
Gift	grob	poison	rude
Gitter	heimtückisch	bar	insidious
Grab	kaputt	grave	broken
Kosten	miserabel	costs	miserable
Lawine	monoton	avalanche	monotonous
Leiche	neidisch	corpse	envious
Räuber	peinlich	robber	embarrassing
Revolver	scheinheilig	revolver	sanctimonious
Schmutz	streng	dust	strict
Schleim	tödlich	slime	deadly
Staub	ungerecht	dirt	unjust
Sumpf	verwundet	morass	injured

Table 4 Mean integrativity ratings of the stimulus pairs used in Experiment 2

German		English		M	SD
Prime	Target	Prime	Target		
High Integrativity					
Positive Prime/Positive Target					
Wald	natürlich	forest	natural	20.29	1.11
Wald	gesund	forest	healthy	19.50	2.35
Wiese	warm	meadow	warm	18.83	2.40
Getränk	warm	drink	warm	18.60	4.99
Geschenk	witzig	present	comical	16.00	8.09
Bild	witzig	picture	comical	15.89	3.69
Blüte	gesund	bloom	healthy	13.83	7.68
Kind	sanft	child	gentle	12.43	6.80
				16.92	4.64
Positive Prime/Negative Target					
Kind	bösartig	child	vicious	19.20	1.79
Getränk	tödlich	drink	dealdy	19.20	1.79
Kind	neidisch	child	envious	18.50	3.70
Bild	peinlich	picture	embarrassing	16.63	5.73
Apfel	tödlich	apple	deadly	16.11	6.43
Duft	streng	scent	strict	15.29	6.55
Meer	heimtückisch	sea	insidious	15.14	6.28
Wald	kaputt	forest	broken	14.80	6.65
				16.86	4.86
Negative Prime/Positive Target					
Lawine	natürlich	avalanche	natural	16.92	3.50
Staub	natürlich	dust	natural	16.60	6.70
Blut	warm	blood	warm	15.57	7.52
Blut	gesund	blood	healthy	15.57	5.74
Sumpf	warm	morass	warm	14.00	5.55
Kosten	fair	costs	fair	13.40	8.26
Bettler	freundlich	beggar	friendly	13.20	5.01
Räuber	phantasievoll	robber	imaginative	13.11	7.25
				14.80	6.19
Negative Prime/Negative Target					
Fabrik	monoton	factory	monotonous	19.14	3.29
Lawine	destruktiv	avalanche	destructive	17.57	7.35
Blut	verwundet	blood	injured	17.00	6.09
Gefängnis	streng	prison	strict	16.22	8.18
Gitter	monoton	bar	monotonous	14.57	8.75
Leiche	brutal	corpse	brutal	13.79	8.66
Revolver	destruktiv	revolver	destructive	12.60	11.50
Gefängnis	miserabel	prison	miserable	10.71	10.06
				15.20	7.99

Table 5 Mean integrativity ratings of the stimulus pairs used in Study 2

German		English		M	SD
Prime	Target	Prime	Target		
Low Integrativity					
Positive Prime/Positive Target					
Strand	fair	beach	fair	3.40	3.92
Getränk	lieb	drink	dear	4.89	4.54
Apfel	kreativ	apple	creative	5.75	3.77
Erdbeere	kreativ	strawberry	creative	6.33	5.24
Getränk	zart	drink	delicate	7.11	6.19
Buch	zart	book	delicate	7.14	4.60
Apfel	fair	apple	fair	9.50	9.27
Meer	witzig	sea	comical	9.71	7.06
				6.73	5.58
Positive Prime/Negative Target					
Wohnung	bösartig	apartment	vicious	3.83	5.42
Apfel	destruktiv	apple	destructive	3.86	4.95
Wiese	scheinheilig	meadow	sanctimonious	4.38	4.10
Kuss	kaputt	kiss	broken	4.63	3.62
Meer	blöde	sea	stupid	4.69	5.71
Duft	kaputt	scent	broken	5.86	6.47
Buch	neidisch	book	envious	6.83	5.23
Wohnung	brutal	apartment	brutal	6.88	6.81
				5.12	5.29
Negative Prime/Positive Target					
Gefängnis	fröhlich	prison	cheerful	1.20	2.17
Räuber	lieb	robber	dear	3.67	3.14
Lawine	kreativ	avalanche	creative	3.86	7.69
Sumpf	lustig	morass	funny	4.86	5.61
Revolver	witzig	revolver	comical	4.86	4.98
Revolver	natürlich	revolver	natural	5.00	4.90
Leiche	zart	corpse	delicate	5.89	5.04
Schmutz	gesund	dirt	healthy	6.00	7.28
				4.42	5.10
Negative Prime/Negative Target					
Kosten	verwundet	costs	injured	2.20	1.92
Fabrik	peinlich	factory	embarrassing	2.33	2.78
Staub	scheinheilig	dust	sanctimonious	2.88	3.18
Sumpf	arrogant	morass	arrogant	4.00	7.68
Grab	neidisch	grave	envious	4.10	4.77
Staub	neidisch	dust	envious	4.63	5.78
Lawine	peinlich	avalanche	embarrassing	5.20	7.92
Blut	arrogant	blood	arrogant	9.50	10.47
				4.35	5.56

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