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The impact of feature-specific attention allocation on the activation of affective stimulus information

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GENERAL INTRODUCTION

INTRODUCTION

The urge to understand human behavior is perhaps the main reason why so many are attracted to the psychological sciences. One does not need to look far, however, to come up with a possible determinant of behavior. The simple evaluation of a stimulus, for instance, seems to be one of the major causes of behavior towards it (e.g., Allport, 1935; Martin & Levy, 1978). To give but one example: we tend to seek contact with the people we like while we tend to avoid those we dislike. Given the widespread influence that evaluation has on behavior, many influential researchers have proposed that the evaluation of a stimulus can take place in an unconditional, automatic fashion (e.g., Arnold, 1960; Bartlett, 1932; Lazarus, 1966; Wundt, 1907). However, it wasn't until the 1980's, after Zajonc published his seminal papers on the primacy of affect, that the automatic stimulus evaluation hypothesis was subjected to a systematic experimental analysis (Zajonc, 1980, 1984).

Many studies indeed found indices of unconditional, automatic stimulus evaluation. Stimulus evaluation emerged as a fast process (e.g. Hermans, De Houwer, & Eelen, 2001) that is independent of cognitive resources (e.g. Hermans, Crombez, & Eelen, 2001), conscious awareness (e.g. Draine & Greenwald, 1998), or current goals and task demands (e.g. Bargh, Chaiken, Raymond, & Hymes, 1996). Support for the automatic evaluation hypothesis has grown steadily over the past decades in both the behavioral sciences (e.g. Fazio, 2001) and the affective neurosciences (e.g. Vuilleumier, 2005). Nevertheless, effects of automatic stimulus evaluation have not always emerged consistently in several studies (e.g. Klauer & Musch, 2001; Pessoa, 2005). If automatic stimulus evaluation is a truly unconditional, automatic process, its effects should be found more readily. Within our lab, we therefore proposed an account that puts automatic evaluation in a new perspective and stresses the crucial role of feature-specific attention allocation (Spruyt, De Houwer, Everaert, & Hermans, 2012; Spruyt De Houwer, & Hermans, 2009; Spruyt, De Houwer, Hermans, & Eelen, 2007). Automatic stimulus evaluation seems to depend crucially on whether or not affective stimulus information is selectively attended to.

In this chapter, I will first review the evidence corroborating the hypothesis that affective stimulus processing can occur in an unconditional and automatic fashion. Next, I will discuss several findings that are inconsistent with this point of view and will present a new framework that can reconcile these inconsistent findings. The chapter closes with a summary of several predictions following this framework and how they were systematically tested over the course of the project.

UNCONDITIONAL, AUTOMATIC AFFECTIVE STIMULUS PROCESSING

To study affective stimulus processing, experimental paradigms are needed that allow one to measure it. Unfortunately, stimulus evaluation cannot be observed directly. It can only be studied by examining its impact on behavior and/or neural activity.

In the behavioral sciences, the affective priming paradigm is perhaps the most acclaimed paradigm that allows for the measurement of affective stimulus processing (Fazio, Sanbonmatsu, Powell, & Kardes, 1986; see Klauer & Musch, 2003, for a review). In this paradigm, participants are usually asked to categorize affectively polarized target stimuli as either “good” or “bad” (i.e. the affective categorization task). Each target stimulus is preceded by the short presentation of an affectively polarized “prime” stimulus that is irrelevant to the task at hand. Performance is generally better when the prime and the target belong to the same affective category (e.g., the words “sunshine” and “kitten”) than when they do not (e.g., the words “sunshine” and “rapist”). This effect can occur only if the affective value of the prime has been processed and thus serves as a marker for the affective processing of the prime stimulus. Aside from the affective priming paradigm, a host of other paradigms have been developed that tap into automatic affective stimulus processing as well. In the affective Simon paradigm (De Houwer & Eelen, 1998), for instance, participants are asked to categorize affectively polarized words as either nouns or adjectives with affectively polarized response labels (‘positive’ and ‘negative’). Even though affective valence is completely irrelevant to the task at hand, performance is usually better when the affective valence of the words matches with the affective valence of the response label (e.g. ‘baby’ and ‘positive’) than when they do not (e.g. ‘friend’ and ‘negative’).

In the neurosciences, two approaches in the measurement of affective stimulus processing can be distinguished. First, neuro-imaging techniques can be used to measure activity in brain regions involved in affective stimulus processing. The amygdala is such a brain structure that has consistently been shown to play a key role in the processing of affective stimuli (LeDoux, 2000; Phelps & LeDoux, 2005; Vuilleumier, 2005). Second, EEG recordings can be used to measure effects of affective stimulus processing on various ERP components related to stimulus processing. The presentation of affective stimuli has been shown to influence components as early as the P1, which occurs roughly 100 ms after stimulus presentation (Smith, Cacioppo, Larsen, & Chartrand, 2003). In fact, nearly every ERP component further down the EEG signal chain appears to be modulated by stimulus affectivity to some extent as well (Carretié, Hinojosa, Martin-Loeches, Mercado, & Tapia, 2004; Olofsson, Nordin, Sequiera, & Polich, 2008). For instance, the P3a, a component related to automatic orienting towards novel stimuli (Polich, 2007), has proven to be especially sensitive to emotional changes in stimuli (Campanella et al., 2002). Moreover, Schupp, Junghöfer, Weike, and Hamm (2003) demonstrated that affective stimuli evoke an early negative deflection in the EEG signal at posterior sites (early posterior negativity), followed by a slow positive wave at parietal sites (late positive potential). Both components are thought to be related to affective modulation of lower and higher stages of stimulus processing respectively (for a review, see Schupp, Flaisch, Stockburger, & Junghofer, 2006).

In both domains, affective stimulus processing has been shown to be processed automatically. Automaticity is best considered an umbrella term that holds several independent features (for a review on automaticity, see Moors & De Houwer, 2006). A first feature is related to the speed of the process under study: A process can be automatic in the sense of being *fast*. A second feature is related to the need for cognitive resources. A process can be automatic in the sense of needing little cognitive resources, thus being *efficient*. A third feature is related to the awareness of the stimulus and the subsequent processing of the stimulus. A process can be automatic when it occurs *outside of the awareness* of the instigating stimulus and the process under study. A fourth feature pertains to a process being automatic in the sense of occurring *independent of the current goals* of a person. This is by no means an exhaustive list of all possible automaticity features mentioned in the literature. The current list does, however, provide sufficient coverage for the present purposes.

In affective priming studies, the presence of these features became apparent through the persistence of the affective priming effect under conditions that impede stimulus processing. Hermans, De Houwer, et al. (2001) concluded affective stimulus processing is *fast* because affective priming effects are largest when the time interval between the onset of the prime and the onset of the target is very short (merely 150 ms). The *efficiency* of affective stimulus processing was demonstrated by Hermans, Crombez, et al. (2001), who asked participants to simultaneously perform an effortful secondary task. Affective priming effects reliably emerged even though the secondary task required ample cognitive capacity. If anything, affective priming effects are even larger when cognitive resources are depleted (Klauer & Teige-Mocigemba, 2007). Also, Draine and Greenwald (1998; Greenwald, Draine, & Abrams, 1996) showed that affective priming effects come about even when the primes are presented below individual recognition thresholds. Affective stimulus processing can thus occur *outside of awareness* of the instigating stimulus as well. One further automaticity feature became apparent when Hermans et al. (1994) and Bargh et al. (1996) used the naming task instead of the affective categorization task. In contrast with the affective categorization task, the naming task does not require one to evaluate the target stimuli but to merely name them. Even under the absence of such an explicit evaluative processing goal, affective priming effects reliably emerged. These findings suggest that affective stimulus processing can even be *independent of an evaluative processing goal*.

In a similar fashion, the presence of automaticity features was deduced from neurophysiological research on affective stimulus processing. Here too, affective stimulus processing emerged as a *fast* process, with stimulus affectivity modulating the EEG signal as early as 100 ms after stimulus presentation (e.g. Carretié et al., 2004; Smith et al., 2003). The *efficiency* of affective stimulus processing was demonstrated by studies showing neural effects of affective stimulation even when participants concurrently performed a secondary task that taxed cognitive resources to a significant extent (e.g. Hajcak, Dunning, & Foti, 2007). Furthermore, affective stimuli were found to modulate neural activity even when they were presented outside the focus of attention (Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Vuilleumier, Armony, Driver, & Dolan, 2001) or *below awareness thresholds* (Kiss & Eimer, 2008; Morris, Öhman, & Dolan, 1998; Vuilleumier et al., 2002; Whalen et al., 1998). Finally, many such studies suggest that affective stimulus processing can also occur *when no evaluative processing goal is present*. For instance, affective modulation of neural activity has been found when participants were asked to merely look at affective stimuli (Schupp et al. 2004) or when they performed a non-emotional task (Schupp et al., 2003; Vuilleumier et al., 2001).

In sum, a myriad of studies has shown affective stimulus processing to possess automaticity-defining features. Furthermore, the wide range of conditions under which effects of affective stimulus processing are found suggest affective stimulus processing occurs in a truly unconditional fashion.

INCONSISTENT FINDINGS

Although the paragraph above paints a picture of a solid, unequivocal phenomenon, several studies produced inconsistent results. More specifically, while many studies suggested that affective stimulus processing can be characterized as an automatic, unconditional phenomenon, it must be emphasized that the effect failed to emerge in a substantial amount of studies too.

Consider, for instance, affective priming of naming responses. This effect initially showed that affective stimulus processing can occur even when an (explicit) evaluative processing goal is absent (Bargh et al., 1996; Hermans et al., 1994). Several researchers later reported that they were unable to replicate this effect. Klauer and Musch (2001) failed to find affective priming of naming responses in a series of four statistically powerful experiments. Affective priming of naming responses failed to emerge regardless of the size of the stimulus set (Experiment 1), the time interval between prime onset and target onset (Experiment 2), the similarity of the procedure to the original Bargh et al. (1996) study (Experiment 3), or the language in which the study was conducted (Experiment 4). Likewise, Spruyt, Hermans, Pandelaere, De Houwer, and Eelen (2004), failed to observe affective priming of naming responses with a nearly exact replication of Bargh et al.’s (1996) study.

Further research eventually pointed out that affective priming of naming responses comes about only under certain preconditions. One such precondition that reliably emerged in several studies is semantic stimulus processing. As the semantic system contains affective stimulus information (e.g. Bower, 1991), a semantic analysis might be a necessary prerequisite for automatic affective stimulus processing to occur. De Houwer, Hermans, and Spruyt (2001), for instance, boosted semantic stimulus processing in the naming task by visually degrading the target words. Pronouncing a word can come about through a direct translation from orthography to phonology, without any involvement of the semantic system. Visually degrading a word hampers this direct translation and allows for more semantic involvement. Consistent with their hypothesis, affective priming of naming responses was found only when the target words were visually degraded. In another study, De Houwer and Randell (2004) made naming conditional on a semantic attribute of the target word, making semantic stimulus processing necessary to correctly perform the task. Again, affective priming of naming responses was found only under these conditions. Another way semantic involvement can be guaranteed is through the use of pictures instead of words, as pictures have privileged access to the semantic system (Glaser, 1992; Glaser and Glaser, 1989). Spruyt, Hermans, De Houwer, and Eelen (2002) indeed found the size of affective priming of naming responses to depend on the modality of the stimuli.

Another precondition is selective attention towards affective stimulus information, which will be discussed extensively in the next section (Spruyt et al., 2007, 2009, 2012). Given these findings, one can hardly advocate that automatic affective stimulus processing occurs in an unconditional fashion. After all, an unconditional process by definition does not rely on preconditions to occur.

Similar observations have been made in the affective neurosciences (for a review, see Pessoa, 2005). In contrast with earlier studies (e.g. Vuilleumier et al., 2001), affective stimuli have shown not to increase amygdala activity (Lange et al., 2003; Pessoa, McKenna, Gutierrez, & Ungerleider, 2002; Pessoa, Padmala, & Morland, 2005; Silvert et al., 2007) or modulate the EEG signal (Doallo, Rodriguez Holguin, & Cadaveira, 2006) in several instances. Pessoa (2005) put forward that authors might have used excessively lenient criteria to assess whether affective stimulus processing is independent of cognitive resources or awareness (e.g. Pessoa, Japee, and Ungerleider, 2005). Many researchers who employed sufficiently rigorous testing conditions did not find effects of affective stimulus processing. These strict testing criteria include: presenting the affective stimuli outside the focus of attention, using a non-emotional task to ensure the absence of an evaluative processing goal, and employing a sufficiently difficult task to deplete cognitive resources.

To sum up, the claim that affective stimulus processing proceeds in an unconditional, automatic fashion seems equivocal at best. Effects of automatic affective stimulus processing are not consistently found over different studies and the alleged unconditionality of automatic affective stimulus processing is therefore challenged.

FEATURE-SPECIFIC ATTENTION ALLOCATION AS A NECESSARY PRECONDITION FOR AUTOMATIC AFFECTIVE STIMULUS PROCESSING

Recently, a new framework was developed at our lab that allows one to reconcile these inconsistencies (Spruyt, 2005; Spruyt et al., 2007, 2009, 2012). According to this framework, automatic affective stimulus processing is modulated by feature-specific attention allocation. More specifically, automatic affective stimulus processing is thought to occur only if and to the extent that affective stimulus information is selectively attended to. Conversely, when selective attention is directed to non-affective semantic stimulus information, enhanced processing of this kind of stimulus information is expected to occur.

Spruyt et al. (2009) demonstrated the viability of this framework with several affective priming studies. In one seminal study, participants were presented with the affective priming paradigm. In 25% of all trials, participants performed the naming task on the target stimuli. In the remaining 75% of all trials, one group of participants performed an affective categorization task while another group of participants performed a non-affective semantic categorization task (i.e., categorize the target stimuli as either animals or objects). Consequently, the former group of participants (the affective group) was encouraged to attend selectively to affective stimulus information whereas the latter group of participants (the non-affective group) was encouraged to attend selectively to semantic non-affective stimulus information. These categorization trials will henceforth be called induction trials because they serve as tools to encourage participants to attend selectively to particular kinds of stimulus information. In accordance with the framework of feature-specific attention allocation, affective priming of naming responses was found only in the affective group. Conversely, in the non-affective group, the only priming effect that was found was a semantic category priming effect regarding the animal and object categories the participants were encouraged to attend to. Spruyt et al. (2007, 2009, 2012) consistently found this modulation effect in five different experiments. Furthermore, these effects occurred even when affective primes were presented subliminally, showing that feature-specific attention allocation modulates automatic affective stimulus processing both at the conscious and the unconscious level (Spruyt et al., 2012).

The framework of feature-specific attention allocation can be conceptualized by representing stimuli in a multidimensional space of which the various dimensions correspond to different stimulus features (e.g. Figure 1). Feature-specific attention allocation acts on this space by stretching those dimensions that are selectively attended to and shrinking those that aren't (Shepard, 1964; Nosofsky, 1986). As a result, differences along the dimensions that receive selective attention become more apparent and easier to process. However, differences along dimensions that are not attended to become less salient and get processed to a lesser extent. This principle is illustrated in Figure 1 with stimuli that were used in the studies of Spruyt et al. (2007).

This multidimensional conceptualization also demonstrates the generality of the framework. Feature-specific attention allocation is thought to influence affective and non-affective stimulus dimensions alike. Furthermore, the framework is not only relevant for semantic stimulus dimensions, but is also applicable to lower-level, perceptual stimulus dimensions. Nosofsky (1986), for instance, applied this principle to the categorization of perceptual stimuli. He asked participants to categorize stimuli according to different perceptual features to encourage them to attend selectively to those features. Afterwards, a multidimensional scaling algorithm was applied to the categorization responses to reconstruct the underlying multidimensional space. In line with the framework of feature-specific attention allocation, the resulting solution showed that a greater weight was applied to those stimulus dimensions that were attended to.

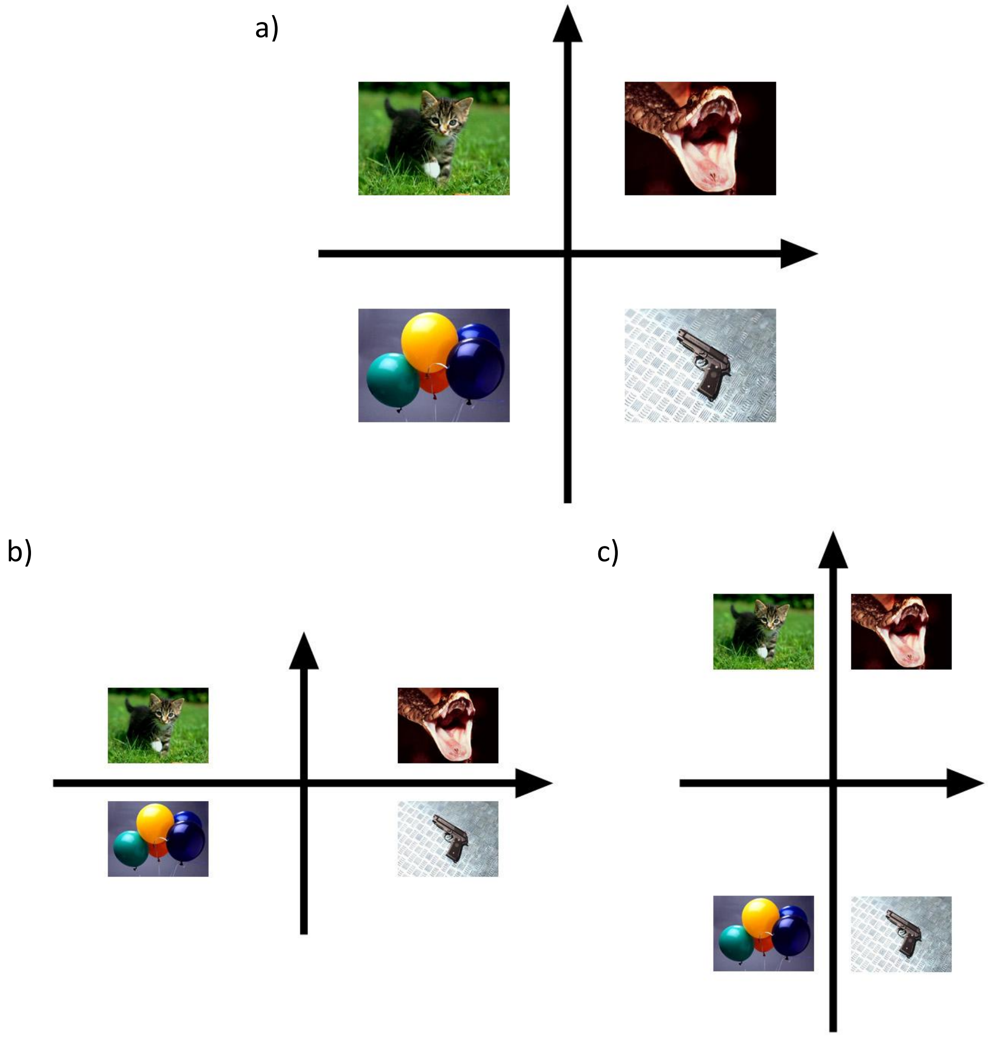

***Figure 1**. Hypothetical example of the multidimensional conceptualization of feature-specific attention allocation. The images represent multidimensional spaces with figures that were used as stimuli in Spruyt et al. (2007). The horizontal axes reflect the affective stimulus dimensions whereas the vertical axes reflect animacy dimensions. Panel a shows the multidimensional representation without effects of feature-specific attention allocation. Panel b shows effects of selective attention towards the affective stimulus dimension. Panel c shows effects of selective attention towards the animacy dimension.*

Nosofsky's (1986) studies are also in line with several neuroscientific findings that show that selective attention to perceptual features modulates neural responses. Single-cell recording studies (see Maunsell & Treue, 2006, for a review) and brain imaging studies (e.g. Corbetta, Miezin, Dobmeyer, Shulman, & Peterson, 1990; Saenz, Buracas, & Boynton, 2002; Serences & Boynton, 2007) have shown neurons in the visual cortex to be more sensitive to stimuli containing a perceptual feature that is attended to, even when the receptive fields of these neurons lie in a location that is not attended to.

IMPLICATIONS OF THE ACCOUNT OF FEATURE-SPECIFIC ATTENTION ALLOCATION: AN OVERVIEW OF THE DISSERTATION

While Spruyt et al. (2009) provided convincing empirical evidence for the general hypothesis that automatic affective stimulus processing depends on feature-specific attention allocation, several crucial implications of this hypothesis remain untested. The aim of the present project is to systematically test these implications in order to further corroborate the framework of feature-specific attention allocation and facilitate practical applications of the framework in the future.

Subtle procedural aspects induce feature-specific attention allocation

The feature-specific attention allocation account states that automatic affective stimulus processing of task-irrelevant stimuli will occur only when selective attention is directed to the affective stimulus dimension. Put differently, this strong claim implies that affective stimulus information must have been attended to if effects of automatic affective stimulus processing are observed. Yet, many indications of automatic affective stimulus processing have been found without explicit manipulations of feature-specific attention allocation. Nevertheless, it could be hypothesized that these studies employed procedures that implicitly encouraged participants to attend to affective stimulus information. Such aspects of the procedure possibly include the wording of the instructions, the content of the informed consent form, the participant's knowledge of the lab's research interests, or the use of extremely affective stimulus sets.

In **Chapter 1**, we examined whether one of these aspects, namely the blatant use of affectively polarized stimuli, affects feature-specific attention allocation and automatic affective stimulus processing. More specifically, we presented participants with an affective priming paradigm in which the naming task was used. One fourth of all trials consisted of regular affective priming trials. These 'experimental' trials were presented together with 'filler' trials that contained affectively polarized stimuli in one group of participants (the affective group) and affectively neutral stimuli in another group of participants (the non-affective group). We hypothesized that the blatant use of affective stimuli in the affective group would encourage participants to selectively attend to affective stimulus information. As a result, automatic affective stimulus processing was predicted to occur in this group, leading to affective priming of naming responses. In the non-affective group, we expected no such effects because affective stimuli were not obviously present throughout the experiment.

Feature-specific attention allocation affects consequences of affective stimulus processing

Feature-specific attention allocation has, up till now, only been demonstrated to affect automatic affective stimulus processing as measured with the affective priming task (Spruyt et al. 2007, 2009, 2012). In this task, automatic affective stimulus processing is measured through some of its consequences, such as response conflict (De Houwer, Hermans, Rothermund, & Wentura, 2002) or facilitation of stimulus encoding (Spruyt et al., 2007). As feature-specific attention allocation affects automatic affective stimulus processing per se, one can assume that it affects other consequences of automatic affective stimulus processing as well.

In **Chapter 2**, we investigated whether selective attention towards affective stimulus information impacts one such a consequence, namely attentional bias to negative stimuli. This particular consequence of affective stimulus processing reflects the power of negative stimuli to draw attention and disrupt performance (for a review, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van

IJzendoorn, 2007). In two experiments, we used two different measures of attentional bias while manipulating feature-specific attention allocation. Induction trials were used to manipulate feature-specific attention allocation, much like the manipulation employed by Spruyt et al. (2009). Participants were encouraged to attend to either affective stimulus information or to a non-affective type of stimulus information, namely whether or not the stimulus denoted a human being or not. Attentional bias was measured using the emotional Stroop task in Experiment 1 and the dot probe task in Experiment 2. In the emotional Stroop task (Williams, Mathews, & MacLeod, 1996), participants are asked to name the colors of sequentially presented words. Task performance is usually worse when the word holds a negative rather than a neutral meaning. This effect is thought to reflect the negative content of the word drawing attention away from the task goals. In the dot probe task (MacLeod, Mathews, & Tata, 1986), participants are asked to respond to the location of sequentially presented dot probes on the screen. Each dot probe presentation is preceded by the presentation of a neutral and a negative picture in two different locations on the screen. Task performance is usually better when the dot probe is presented on the location in which a negative picture was presented previously rather than when the dot probe is presented on the location in which a neutral picture was presented previously. This effect is thought to reflect the negative picture drawing attention to its location and consequently affecting the localizing of the dot probe. Attentional bias towards negative stimuli was expected to occur only when feature-specific attention was directed to affective stimulus information. In contrast, when participants were encouraged to attend to stimulus information necessary for the discrimination of humans from non-humans, an attentional bias towards stimuli that denoted humans was expected.

In **Chapter 3**, the impact of feature-specific attention allocation on another, neural manifestation of attentional bias was examined. When a set of stimuli is presented sequentially in a predictable fashion, the occurrence of an unpredictable stimulus in this sequence captures attention, which can be measured using electrophysiological recordings (EEG). The P3a is an ERP component that reflects this attentional capture (e.g. Polich, 2007) and has been shown to be larger when the unpredictable stimulus differs from the predictable stimuli in its affective value than when it does not (Campanella et al., 2002). In one EEG study, we aimed to show that this effect of affective, unpredictable stimuli on P3a size is also modulated by feature-specific attention allocation. To demonstrate this, we presented participants with sequences of neutral faces in which rare, unpredictable faces were presented that could differ from the predictable faces with respect to either the emotion they display or the age they have. One group of participants was encouraged to attend to the affective value of the presented stimulus faces, while another group of participants was encouraged to attend to the age of the faces. We expected the size of the P3a to be contingent on the feature that was selectively attended to. When the unpredictable face deviated from the predictable faces with respect to the emotion it displayed, a significant P3a component was expected only when participants attended to emotional, affective stimulus information. When the unpredictable face deviated from the predictable faces with respect to the age it portrayed, a significant P3a component was expected only when participants attended to age-related stimulus information.

Feature-specific attention allocation can be measured using multidimensional scaling

As mentioned above, modulation of feature-specific attention allocation can be conceptualized by representing stimuli in a psychological, multi-dimensional space. The dimensions of this space correspond to the various stimulus features on which the stimuli can vary (e.g. age, emotion, color, …). Feature-specific attention allocation selectively stretches those stimulus dimensions that are attended to while it shrinks those that are not. As a result, differences along the dimensions that are attended to become more apparent and easier to process, while the opposite occurs for stimulus dimensions that are not attended to. Several multidimensional scaling techniques have been developed that allow for the visualization of this psychological space and the effects of feature-specific attention allocation on it (Carroll & Chang, 1970; Commandeur & Heiser, 1993; Young, 1982).

In **Chapter 4**, we used such a multidimensional scaling technique to measure the degree to which different stimulus dimensions are attended to. In future studies, we would aim to use such measures as a manipulation check and to test whether automatic affective stimulus processing is linearly dependent on feature-specific attention allocation. We therefore set out to test whether multi-dimensional scaling algorithms could be a valuable tool for the measurement of feature-specific attention allocation. We employed Spruyt et al.'s (2009) manipulation of feature-specific attention allocation and used a multi-dimensional scaling technique (INDSCAL; Carroll & Chang, 1970) to model the subjects' psychological space. In accordance with earlier studies, we expected the selective stretching of the participants' psychological spaces to coincide with those stimulus dimensions they were encouraged to attend to, regardless of whether the stimulus dimension was affective or not.

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CHAPTER 1

ON THE (UN)CONDITIONALITY OF AUTOMATIC ATTITUDE ACTIVATION: THE VALENCE PROPORTION EFFECT [1]

Affective priming studies have shown that participants are faster to pronounce affectively polarized target words that are preceded by affectively congruent prime words than affectively polarized target words that are preceded by affectively incongruent prime words. We examined whether affective priming of naming responses depends on the valence proportion (i.e. the proportion of stimuli that are affectively polarized). In one group of participants, experimental trials were embedded in a context of filler trials that consisted of affectively polarized stimulus materials (i.e., high valence proportion condition). In a second group, the same set of experimental trials was embedded in a context of filler trials consisting of neutral stimuli (i.e., low valence proportion condition). Results showed that affective priming of naming responses was significantly stronger in the high valence proportion condition than in the low valence proportion condition. We conclude that (a) subtle aspects of the procedure can influence affective priming of naming responses, (b) finding affective priming of naming responses does not allow for the conclusion that affective processing is unconditional, and (c) affective stimulus processing depends on selective attention for affective stimulus information.

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[1] Based on Everaert, T., Spruyt, A., & De Houwer, J. (2012). On the (un)conditionality of automatic attitude activation: The valence proportion effect. *Canadian Journal of Experimental Psychology, 65,* 125-132.

INTRODUCTION

Throughout the history of psychology, researchers have advocated the idea that humans are equipped with a mechanism capable of automatically evaluating the affective value of all incoming stimulus information (e.g., Arnold, 1960; Bartlett, 1932; Lazarus, 1966; Wundt, 1907; Zajonc, 1980, 1984). One paradigm often used to study automatic stimulus evaluation is the affective priming paradigm (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). In a typical affective priming study, participants are asked to evaluate several affectively polarized target stimuli as positive or negative as fast as possible (i.e. the evaluative categorization task). Each of these targets is preceded by an affective prime stimulus. Typically, it is observed that performance is faster and more accurate when prime and target are affectively congruent (e.g., 'HAPPY' – 'KITTEN') than when they are affectively incongruent (e.g., 'TENDER' – 'PEDOPHILE'), a phenomenon referred to as the affective priming effect (for reviews, see De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009; Fazio, 2001; Klauer & Musch, 2003). Crucially, such an effect can occur only if the affective meaning of the prime has been processed. Therefore, the affective priming effect can be conceived of as a cognitive marker of affective stimulus processing.

Consistent with the hypothesis that stimulus evaluation occurs in an unconditional, automatic fashion, the affective priming effect has proven to be a rather robust phenomenon. For instance, affective priming effects have been obtained while participants performed an effortful secondary task (Hermans, Crombez, & Eelen, 2000; also see Klauer & Teige-Mocigemba, 2007) and when using short stimulus onset asynchronies (Hermans, De Houwer, & Eelen, 2001), subliminal prime presentations (Draine & Greenwald, 1998; Greenwald, Draine, & Abrams, 1996), and stimuli from different modalities (Hermans, Baeyens, & Eelen, 1998; Hermans, De Houwer, & Eelen, 1994; Spruyt, Hermans, De Houwer, & Eelen, 2002).

Also, whereas most affective priming studies employed the evaluative categorization task (see above), both Bargh, Chaiken, Raymond, and Hymes (1996) and Hermans, De Houwer, and Eelen (1994) obtained significant affective priming effects using a word naming task. Unlike the evaluative categorization task, the naming task does not require participants to adopt an explicit evaluative processing goal. The findings of Bargh et al. and Hermans et al. therefore suggest that affective stimulus processing does not depend on the activation of an explicit evaluative processing mindset.

Evidence concerning the reliability of the affective priming effect in the naming task is mixed however. Spruyt, Hermans, Pandelaere, De Houwer, and Eelen (2004), for example, were unsuccessful in obtaining the effect in a nearly exact replication of Bargh et al.'s (1996) Experiment 2. Likewise, Klauer and Musch (2001) failed to replicate this effect in a series of four statistically powerful experiments (see also, De Houwer, Hermans, & Eelen, 1998). In contrast, Spruyt, Hermans, De Houwer, and Eelen (2002) demonstrated that affective priming of naming responses can be readily obtained when pictures are used as primes and targets but not when words are used as primes and targets (see also Wentura & Frings, 2008).

To explain these inconsistent findings, De Houwer and Randell (2004; also see De Houwer, Hermans, & Spruyt, 2001) suggested that affective priming of naming responses depends on the extent to which naming is semantically mediated. Because affective stimulus information is stored within the semantic system (e.g., Bower, 1991), one can indeed expect that affective stimulus processing is more likely to take place when an in-depth semantic analysis of the target stimuli is required. In line with this hypothesis, De Houwer and Randell obtained reliable affective priming of naming responses when participants were asked to name only those target words that did not belong to a specific semantic category (Experiment 2). In contrast, when the naming of the targets was conditional upon the color of the word rather than its semantic category, no affective priming was obtained (Experiment 1). Also consistent with the idea that affective priming of naming responses depends on the extent of in-depth semantic processing is the observation that affective priming in the naming task is typically more robust and replicable when pictures instead of words are used as primes and targets (Spruyt et al., 2002). Pictures are known to have privileged access to the semantic system (Glaser, 1992; Glaser and Glaser, 1989). Pictorial primes will therefore activate affective stimulus information to a higher degree than do words. Moreover, because pictures first have to activate their concept nodes within the semantic system before they can be named (Glaser, 1992; Glaser and Glaser, 1989), picture naming is always semantically mediated.

Recent studies conducted by Spruyt, De Houwer, and Hermans (2009; also see Spruyt, De Houwer, Hermans, & Eelen, 2007) suggest an alternative, more fine-grained interpretation, however. Spruyt et al. put forward that automatic semantic stimulus processing is modulated by feature-specific attention allocation. More specifically, they argued that the semantic analysis of a task-irrelevant stimulus is more pronounced for those stimulus dimensions that are selectively attended to. Given the assumption that affect can be regarded as a semantic dimension (e.g., Bower, 1991; De Houwer & Hermans, 1994; Fiske & Pavelchak, 1986), the hypothesis of Spruyt et al. thus implies that automatic affective processing of task-irrelevant stimuli will depend on the extent to which affective stimulus information is selectively attended to.[1]

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[1] Following the guidelines of Moors and De Houwer (2006), we adhere to a feature-based, decompositional approach to the definition and diagnosis of automaticity. According to this viewpoint, different automaticity features can be conceptually and logically separated and should therefore be studied independently from each other. It thus makes little sense to classify a process as non-automatic simply because it is found to depend on a particular (set of) precondition(s). Accordingly, the hypothesis that affective priming of naming responses depends on feature-specific attention allocation does not imply that affective processing is a non-automatic processes.

Spruyt et al. (2009), for instance, manipulated the degree to which attention was assigned to the affective stimulus dimension by asking participants to classify the targets on the basis of their affective connotation on either 25% or 75% of all trials (Experiment 1). Consistent with the selective-attention framework, affective priming of naming responses was significantly stronger in the 75 % evaluation condition than in the 25% evaluation condition.

Based on these findings, one could argue that the affective stimulus dimension was selectively attended to in prior studies that did produce affective priming of naming responses (e.g., Bargh et al., 1996; Hermans et al., 1994). Consider, for example, the findings of De Houwer and Randell (2004). A closer look at their procedures reveals that it may have been an efficient strategy for participants to selectively assign attention to affective stimulus information. In both studies, all to-be-named words had a clear affective connotation (e.g., 'TERRIFIC') whereas all to-be-ignored targets were affectively neutral. In other words, stimulus valence was informative about whether a naming response was required or not. This subtle procedural feature may have encouraged participants to adopt a strategic evaluative processing goal (but see Pecchinenda, Ganteaume, & Banse, 2006).

Feature-specific attention allocation may also have been responsible for the findings obtained with the picture – picture naming task (Spruyt et al, 2002; Wentura & Frings, 2008). Spruyt et al. showed that pictures are more effective as primes and more susceptible to priming as targets. In their studies, however, there might have been a confound between stimulus modality and the degree to which participants were encouraged to assign attention to the affective stimulus dimension. Because the emotional tone of pictures used in affective priming studies is typically more extreme than the emotional tone of words, pictures may be more effective in inducing selective attention for the affective stimulus dimension than words (Spruyt et al., 2009).

Evidence obtained with the affective Simon task (De Houwer & Eelen, 1998) points even further in this direction (Duscherer, Holender, & Molenaar, 2008). In this affective variant of the spatial Simon task (Simon, 1990; Simon & Rudell, 1967), participants are presented with words that vary independently on both the affective stimulus dimension and a nonaffective stimulus dimension (e.g., grammatical category). Crucially, participants are asked to categorize the words on the basis of the nonaffective stimulus dimension while using response labels that are affectively polarized (e.g., 'good'-'bad'). The irrelevant affective value of the stimulus words can thus either be congruent or incongruent with those of the response labels. Although the affective connotation of the words itself is irrelevant for the task at hand, one commonly observes slower and less accurate responses when the word and the response are affectively incongruent than when they are congruent. Duscherer et al. (2008) manipulated the proportion of affective Simon trials on which affectively polarized stimuli were presented and found the affective Simon effect in the response latency data to come about only if the proportion of trials consisting of affectively polarized stimulus materials was high.

This finding is important because it suggests that selective attention for affective stimulus information can be manipulated not only in a blatant manner via instructions and task demands (as in the studies of Spruyt et al., 2007, 2009) but also in a procedurally more subtle manner, that is, by varying the proportion of affective stimuli. To substantiate this idea, however, several issues need to be dealt with first.

First of all, it should be emphasized that the findings of Duscherer et al.'s were not conclusive. Although the valence proportion had an impact on the affective Simon effect in the reaction time data, a similar data pattern did not emerge in the error data. In fact, the error data revealed an affective Simon effect irrespective of the proportion of affectively polarized stimuli. One procedural detail that might account for this data pattern concerns the response labels used. While Duscherer et al. took great care in manipulating the proportion of affective stimuli, the applied response labels were affectively polarized throughout the entire experiment ("positive" or "negative"). That is, irrespective of whether the proportion of trials consisting of affectively polarized stimulus materials was high or low, participants still had to execute an affectively labeled response on all trials. As pointed out by Spruyt, Everaert, De Houwer, Moors, and Hermans (2008), the use of affectively polarized response labels can prompt one to selectively attend the affective stimulus dimension. It is therefore important that the valence proportion is manipulated in such a way that the proportion of affectively polarized responses is also low.

Second, even if the data of Duscherer et al. (2008) would have been conclusive, it still remains to be seen to what extent their findings generalize to other experimental tasks. It is possible, for instance, that the valence proportion moderates the affective Simon effect not because it influences automatic affective processing per se but because it influences the processes that mediate between automatic affective processing and the affective Simon effect, such as response competition (see Gawronski, Deutsch, LeBel, & Peters, 2008; Moors, Spruyt, & De Houwer, 2009; Spruyt, Gast, & Moors, 2011). To rule out such an interpretation, studies using other experimental tasks are vital.

In the present experiment we examined whether the valence proportion of affective stimuli modulates affective priming of naming responses too. More specifically, we embedded critical naming trials in a large set of filler trials that either consisted of neutral stimuli (low valence proportion) or affective stimuli (high valence proportion). The affective priming effect was expected to be significantly stronger in the high valence proportion condition than in the low valence proportion condition. This experiment is important for several reasons. First of all, it is generally assumed that affective priming in the naming task is driven by processes other than those underlying the affective Simon effect (e.g., De Houwer, 2006; Gawronski et al., 2008; Moors et al., in press). Evidence that the valence proportion also influences priming effects in the naming task would therefore provide important additional support for the hypothesis that the proportion of affective stimuli influences the probability of affective stimulus processing rather than processes specific to the affective Simon effect. Second, in a naming task, the proportion of affectively polarized responses is equal to the proportion of affectively polarized stimuli presented. The naming task is therefore better suited to study the impact of the valence proportion on automatic affective stimulus processing.

Finally, the present study is important because it sheds new light on the conditions under which affective priming of naming responses can be obtained.

METHOD

Participants

Due to the small to medium effect sizes generally associated with affective priming of naming responses, we performed a power analysis using a power coefficient of 0.80 and an effect size (*d* = 0.35) obtained in a study with similar stimulus materials and procedure (Spruyt & Hermans, 2008). This analysis revealed an optimal sample size of 67 for each between-subjects condition, resulting in an optimal total sample size of 134. We therefore recruited 106 undergraduates at Ghent University (mean age = 19 years; 31 men, 75 women), with an implied power estimate of about 0.74 to detect a priming effect in each between-subjects condition. All participants took part of the study in exchange for course credit or a payment of € 8.

Materials

We used 60 prime pictures (30 positive and 30 negative) and 40 target words (20 positive nouns and 20 negative nouns) as experimental stimuli. These stimuli were used to create the experimental trials and were equal in both the low valence proportion and the high valence proportion condition. The prime pictures were selected on the basis of normative data collected by Spruyt et al. (2002). On a scale ranging from very negative (-5) to very positive (5), the mean affective ratings of the positive (*M* = 2.23, *SE* = 0.10) and negative prime pictures (*M* = -2.87, *SE* = 0.20) were significantly different, *t*(58) = 22.61, *p* < .001. The target words were taken from a list of Dutch words that were rated on a 7-point scale ranging from 0 (very negative) to 7 (very positive) (Hermans & De Houwer, 1994). The mean affective rating for the positive targets (*M* = 6.16, *SE* = 0.08) was significantly higher than that for the negative targets (*M* = 1.49, *SE* = 0.05) and significantly different, *t*(38) = 47.11, *p* < .001.

The primes for the filler trials were taken from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999) and consisted of 20 neutral pictures (*M* = 5.21, *SE* = 0.11), 10 positive pictures (*M* = 7.72, *SE* = 0.13), and 10 negative pictures (*M* = 2.73, *SE* = 0.09). The mean affective rating of the neutral primes differed significantly from that of the positive, *t*(28) = 13.79, *p* < .001, and the negative primes, *t*(28) = 14.67, *p* < .001. Obviously, the mean affective ratings of the positive and negative primes were significantly different as well, *t*(18) = 30.93, *p* < .001.

The filler targets were taken from the word norms collected by Hermans and De Houwer (1994). These were 30 neutral nouns (*M* = 4.10, *SE*=.03), 15 positive nouns (*M* = 6.1, *SE* = 0.09), and 15 negative nouns (*M* = 1.56, *SE* = 0.05). The mean affective ratings of the neutral nouns different significantly from both the positive and negative nouns, *t*(43) = 24.26, *p* < .001, and *t*(43) = 44.13, *p* < .001, respectively. The difference in mean affective ratings of the positive and negative targets was also reliable, *t*(28) = 44.42, *p* <. 001. The filler trials in the low valence proportion condition were constructed using the neutral primes and targets. The affectively polarized stimuli were used to construct the filler trials in the high valence proportion condition.

All pictures were sized to a width of 512 pixels and a height of 384 pixels. Target words were presented in a white, Arial font with a height of 28 pixels. All stimuli were presented against the black background of a 19-inch computer monitor with a refresh rate of 100 Hz and a screen resolution of 1024 × 768. The experiment was run using Affect 4.0 (Spruyt, Clarysse, Vansteenwegen, Baeyens, & Hermans, 2009). The responses were registered with an external voice key that was connected to the parallel port of the computer.

Procedure

Participants were randomly assigned either to the low valence proportion condition (*n* = 54) or the high valence proportion condition (*n* = 52). They were seated in front of the computer screen in a dimly-lit room. Instructions appeared on screen and were clarified by the experimenter when necessary. Participants were instructed to pronounce the target words as fast and as accurately as possible. They were informed that the prime pictures were irrelevant for the task. Participants in both conditions received the same set of experimental trials. In the low valence proportion condition experimental trials were embedded in a context of neutral filler trials. In the high valence proportion condition experimental trials were embedded in a context of affective filler trials.

For each participant, 40 experimental trials were created by randomly combining the experimental primes and targets with the restriction that each trial type (positive-positive, positive-negative, negative-positive, negative-negative) occurred equally often. Because there were more prime pictures than experimental trials, a subset of 40 pictures was randomly drawn for each participant. There was no stimulus repetition for the experimental trials.

Participants were presented with 120 additional filler trials. In the high valence proportion condition, these filler trials were composed of affective primes and targets that were randomly combined with the restriction that each trial type (positive-positive, positive-negative, negative-positive, negative-negative) occurred equally often. The filler trials in the low valence proportion condition consisted of neutral primes and targets that were combined in a purely random fashion. Because of the large number of filler trials, stimulus repetition was allowed for all filler trial types. The exact number of stimulus repetitions on the filler trials was not controlled for.

The experiment started with 12 practice trials, followed by 160 randomly intermixed experimental and filler trials. The practice trials were randomly selected from the complete set of filler trials.

Each trial started with a 500-ms presentation of a fixation cross in the center of the screen, followed by a 500-ms blank screen. The prime picture was presented for 200 ms and the target appeared after a stimulus onset asynchrony (SOA) of 250 ms. The target word was then presented until a response was detected or 2000 ms elapsed. Once the experimenter had coded the response, the next trial was initiated after an intertrial interval (ITI) that varied randomly between 500 ms and 1500 ms.

RESULTS

Only the data of the experimental trials were analyzed. Because the error rates associated with the experimental trials were very low (0.12 %), we limited our analyses to the response latencies. Data from experimental trials on which an incorrect response was given (0.12 %) or trials on which the voice key was triggered incorrectly (4.08 %) were excluded from the analysis. The impact of outlying values was reduced by excluding all response latencies (0.40 %) that deviated more than 2.5 standard deviations from a participant's mean latency in a particular condition (see Ratcliff, 1993). The remaining data were submitted to a 2 (valence proportion: low vs. high) x 2 (prime valence: positive vs. negative) x 2 (target valence: positive vs. negative) repeated measures ANOVA. Mean response latencies are provided in Table 1.

Table 1.

Mean Response Latencies and SDs for each Trial Type (in ms) as a Function of Condition.

	Trial type							
Valence	(+,+)		(+,-)		(-,+)		(-,-)	
Proportion	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Low	475	49	500	57	477	52	508	56
High	464	48	496	59	477	46	499	54

Note. (+,+) = positive prime, positive target; (+,-) = positive prime, negative target; (-,+) = negative prime, positive target; (-,-) = negative prime, negative target.

The main effects of prime valence, *F*(1, 104) = 12.46, *p* < .001, *MSE* = 346, *f* = 0.35, and target valence, *F*(1, 104) = 132.17, *p* < .001, *MSE* = 603, *f* = 1.13, were both significant but did not interact, *F*(1,104) < 1. Targets preceded by positive primes were responded to more quickly than targets preceded by negative primes (mean difference of 6 ms; *SD* = 19 ms) and positive targets were responded to faster than negative targets (mean difference of 27 ms; *SD* = 24 ms). Importantly, the crucial three-way interaction between valence proportion, prime valence, and target valence was significant, *F*(1, 104) = 5.72, *p* < .05, *MSE* = 316, and had a reasonable effect size, *f* = 0.23. To further investigate the nature of this three-way interaction, two separate 2 (prime valence: positive vs. negative) x 2 (target valence: positive vs. negative) repeated measures ANOVAs were conducted, one for each valence proportion condition. The interaction between prime valence and target valence was significant in the high valence proportion condition, *F*(1, 51) = 4.21, *p* < .05, *MSE* = 335. There was a 5 ms (*f* = 0.29) difference between affectively congruent and incongruent trials (for our effect size estimation procedure, see Rosenthal & Rosnow, 1991). In the low valence proportion condition, the interaction between prime valence and target valence did not reach significance, *F*(1,53) < 1.7, *p* = .19, *MSE* = 297, *f* = 0.18 (see Table 2, for the affective priming effects).

Table 2.

Mean Response Latencies and SDs for each Trial Type and Affective Priming Effects (in ms) as a Function of Condition.

Valence Proportion	Trial type: Congruent *M*	Trial type: Congruent *SD*	Trial type: Incongruent *M*	Trial type: Incongruent *SD*	APE *M*	APE *SD*
Low	492	50	489	51	-3	17
High	482	49	487	51	5*	18

Note. APE = affective priming effect.

**p* < .05, two-tailed.

Note that, in the high valence proportion condition, both the main effect of prime valence and the main effect of target valence also reached significance. More specifically, positive target trials were responded to faster than negative target trials, *F*(1,51) = 73.81, *p* < .001, *MSE* = 508, *f* = 0.44, and positive prime trials were responded to faster than negative prime trials, *F*(1,51) = 9.99, *p* < .01, *MSE* = 304, *f* = 1.20. As a result, it is difficult to interpret affective priming effects for specific subsets of trials. For example, a comparison of positive and negative target trials within each level of prime valence would lead to an overestimation of the affective priming effect on positive prime trials and an underestimation on negative prime trials. Similarly, a comparison of positive and negative prime trials within each level of target valence would lead to an overestimation of the affective priming effect on positive target trials and an underestimation on negative target trials. In line with this reasoning, the difference between congruent and incongruent primes was statistically reliable on positive target trials *F*(1,51) = 15.54, *p* < .001, *MSE* = 276, *f* = 0.55. but not on negative target trials (*F* <1, see Table 1). Likewise, a comparison between congruent and incongruent targets revealed a highly significant affective priming effect for positive prime trials, *F*(1,51) = 64.50, *p* < .001, *MSE* = 414, *f* = 1.12, and even a significant contrast effect for negative prime trials, *F*(1,51) = 28.40, *p* < .001, *MSE* = 429, *f* = 0.75. It must be clear however that these contrasts are deflated/inflated by main effects of prime valence and target valence. For these reasons, we are reluctant to calculate affective priming effects for one category of prime valence or target valence (also, see Dijksterhuis & Aarts, 2003).

DISCUSSION

According to the selective-attention framework of semantic priming put forward by Spruyt et al. (2009), the semantic analysis of task-irrelevant stimuli depends on the extent to which specific (semantic) stimulus dimensions are selectively attended to. In line with this framework, previous studies have shown that affective stimulus processing depends strongly on the extent to which attention is assigned to the affective stimulus dimension (e.g., Spruyt et al., 2007, 2009). In each of these studies, however, feature-specific attention allocation was manipulated in a salient manner via explicit instructions and task requirements. The merits and scope of the selective-attention framework put forward by Spruyt et al. (2009) would be severely limited if only such manipulations would have effect on automatic semantic stimulus processing. In the present study we examined whether affective priming in the naming tasks depends on the number of trials that consisted of affectively polarized stimulus materials (i.e., the valence proportion). In line with our expectations, we observed that the affective priming effect in the naming task was modulated by the valence proportion. As indicated by the significant three-way interaction between prime, target, and condition, affective priming was more pronounced in the high valence proportion condition than in the low valence proportion condition. This data pattern shows that procedurally subtle manipulations of feature-specific attention allocation can have a clear impact on automatic affective stimulus processing, and on automatic semantic stimulus processing in general.

Our findings shed new light on the mixed findings that have been obtained earlier with the naming task. In contrast to the many failures to observe affective priming of naming responses (e.g., Klauer & Musch, 2001; Spruyt et al., 2004), Spruyt et al. (2002) did observe robust effects when pictures instead of words were used as primes and targets. According to the selective-attention hypothesis, this effect results from the fact that the pictures used in affective priming research are typically very graphic and more extreme in their affective meaning than words. Pictures might therefore be more successful in inducing selective attention for affective stimulus information as do words. Our results support this hypothesis by showing that a subtle, non-instructional element of the procedure such as the valence proportion can influence affective priming effects. Of course, some published studies did show affective priming of naming responses despite the fact that neither pictures were used nor special measures were taken to draw attention to the valence of the stimuli (Bargh et al., 1996; Hermans et al., 1994). We can only speculate about the precise procedural factors that were responsible for these findings. Irrespectively, our results do show that subtle, non-instructional aspects of the procedure (such as the precise set of stimuli that is used) can influence the magnitude of the affective priming effect.

Our findings are also important for the discussion concerning the automaticity of affective stimulus processing. Given that the naming task does not require one to adopt an (explicit) evaluative processing mindset, it has been argued that finding affective priming of naming responses provides strong evidence for the hypothesis that automatic affective stimulus evaluation can take place in an unconditional fashion. The present data clearly show, however, that finding an affective priming effect in the naming task is still insufficient to warrant such a conclusion. Even so, it should be emphasized that our findings are not necessarily inconsistent with the generic idea that affective stimulus processing can proceed in an automatic fashion. In accordance with a decompositional view of automaticity (Moors & De Houwer, 2006, see also Footnote 1), we merely contest the alleged unconditonality of automatic affective stimulus processing, not the idea that affective stimulus information can be processed in an automatic fashion under certain conditions per se.

Finally, we would like to point out that the present reasoning is valid only if one assumes that the magnitude of the affective priming effect is directly related to the extent of affective stimulus processing. In contrast, one might argue that the effect of feature-specific attention allocation on affective priming is situated at the level of the processes that translate affective processing into affective priming effects rather than at the level of affective processing itself (e.g., Gawronski, et al., 2008; Moors et al., 2010; Spruyt, Gast, & Moors, 2011). More reliable claims could be made when different measures of affective stimulus processing provide similar outcomes despite the fact that different underlying mechanisms are at play. The fact that our results converge with those obtained by Duscherer et al. (2008) with the affective Simon task therefore suggests that the effect of feature-specific attention allocation is not paradigm-specific. Nevertheless, studies that confirm the impact of feature-specific attention allocation on other indices of automatic affective stimulus processing are needed to firmly substantiate our claims. Recently, our lab undertook such efforts (Everaert, Spruyt, & De Houwer, 2012) using the emotional Stroop paradigm (Pratto & John, 1991). Mirroring Spruyt et al. (2009), we presented participants with trials that were traditional emotional Stroop trials or trials that were aimed at inducing attention allocation to a specific stimulus feature. As expected, the emotional Stroop effect was stronger when participants selectively attended the affective stimulus dimension.

In summary, the present experiment demonstrated a clear impact of valence proportion on affective priming of naming responses. Affective priming was stronger when the proportion of affective stimuli was high compared to when this proportion was low. We attributed this result to differences in feature-specific attention allocation evoked by different proportions of affective information. These findings underline the fact that the observation of affective priming effects in the naming task is insufficient to conclude that affective processing is unconditional.

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APPENDIX

Stimuli in the experimental list

Positive prime pictures. balloons; a rose; a teddy bear; a butterfly; a smiling woman; a waterfall; a sunset; a kitten; a bride; a present; a father with baby; a naked couple hugging; a nude female swimmer; a tropical coast; two smiling people making the peace sign; a couple; newlyweds; a dolphin; a squirrel; a baby; a candle; an air balloon; a Christmas tree; smiling man; white clouds; a rainbow; a pretty woman; a smiling baby; a strawberry; an orange.

Negative prime pictures. barb wire; an inflamed breast; an angry man; gun pointed at the camera; a bloody dead calf; a knife held against a female neck; a gun pointed at a woman; a man running with an injured child in his arms; trash; a car crash; a crying African child; a starved woman; maggots; an explosion; a gasmask; an injured man; a white shark; a spider; a dog with exposed teeth; a dead dog in a slaughterhouse; an injection; a floating corpse; injured lips; a wounded man; a crying man; a snake; a gun; skulls; a baby with a tumor; a house on fire.

Positive target words. LIEFDE (love); VRIEND (friend); VAKANTIE (vacation); VREDE (peace); TROUW (loyal); ROMANTIEK (romance); MUZIEK (Music); THUIS (home); HUMOR (comedy); LEVEN (life); WARMTE (warmth); FEEST (party); DROOM (dream); GEZONDHEID (health); APPLAUS (applause); TROTS (pride); SCHOONHEID (beauty); LACH (smile); ZOMER (summer); KNUFFEL (hug).

Negative target words. MOORD (murder); VERKRACHTING (rape); INCEST (incest); STANK (stench); AIDS (aids); MARTELING (torture); TUMOR (tumor); HAAT (hate); ONGELUK (accident); ALCOHOLISME (alcoholism); PEDOFIEL (pedophile); SLACHTING (slaughter); COMA (coma); HEL (hell); INFECTIE (infection); WERKLOOSHEID (unemployment); SADIST (sadist); BRAAKSEL (vomit); TIRAN (tyrant); VERSTIKKING (suffocation).

Stimuli in the valent context list

Positive prime pictures (IAPS numbers). 1440; 1463; 1604; 1750; 1920; 2070; 2311; 2550; 5831; 7430.

Negative prime pictures (IAPS numbers). 2276; 2750; 3300; 9000; 9001; 9041; 9220; 9280; 9290; 9561.

Positive target words. KUS (kiss); OMHELZING (embrace); ZON (sun); BLOEMEN (flowers); LENTE (spring); GESCHENK (gift); VERRASSING (surprise); CADEAU (present); BRUID (bride); BLOESEM (blossom); VLINDER (butterfly); WENS (wish); HEMEL (heaven); BOEKET (bouquet); MELODIE (melody).

Negative target words. OORLOG (war); EXECUTIE (execution); BOMMEN (bombs); KANKER (cancer); GEZWEL (swelling); MISDAAD (crime); GEWEREN (rifles); KOGEL (bullets); DRUGS (drugs); ZIEKTE (disease); GANGSTER (gangster); GIJZELAAR (hostage); BEDREIGING (threat); VIRUS (virus); LIJK (corpse).

Stimuli in the neutral context list

Neutral prime pictures (IAPS numbers). 2214; 2280; 2575; 5395; 5455; 5535; 6150; 7095; 7096; 7130; 7186; 7190; 7207; 7211; 7495; 7550; 7560; 7620; 7820; 7830.

Neutral target words. DOOS (box); PAPIER (paper); DISCO (disco); BORD (plate); TAS (cup); STOEP (pavement); STREEP (line); VIERKANT (square); ACCENT (accent); BOOG (bow); GIST (yeast); TROMPET (trumpet); VERGELIJK (agreement); LIJN (line); POOL (pole); PARADE (parade); SCHAAR (scissors); TAND (tooth); AGENTSCHAP (agency); TRAPEZIUM (trapezium); KAPPER (hairdresser); TAPIJT (carpet); MAGAZINE (magazine); KRANT (newspaper); HOED (hat); STOEL (chair); BALPEN (ball pen); MAND (basket); TAFEL (table); CIRKEL (circle).

CHAPTER 2

ON THE MALLEABILITY OF AUTOMATIC ATTENTIONAL BIAS:
EFFECTS OF FEATURE-SPECIFIC ATTENTION ALLOCATION [1]

In two experiments, we examined the extent to which automatic attentional biases, as indexed by performance in the emotional Stroop task (Experiment 1) and the dot probe task (Experiment 2), are modulated by feature-specific attention allocation. In both experiments, participants were encouraged to attend to either affective stimulus information (affective groups) or non-affective, semantic stimulus information (non-affective groups). Attentional bias towards negative stimuli was found in the affective groups but not in the non-affective groups. In Experiment 1, we also observed an attentional bias towards non-affective semantic stimulus information in the non-affective groups but not in the affective groups. We argue that these effects are due to a modulation of automatic stimulus processing by feature-specific attention allocation, which consequently affects automatic attentional biases. Our data demonstrate that automatic attentional biases toward negative stimuli are not unconditional but depend on the relevance of negative information. Moreover, the results of Experiment 1 suggest that attention is automatically allocated also to non-affective stimulus dimensions that are currently relevant.

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INTRODUCTION

It is a well-established fact that the affective connotation of a stimulus can be processed in a fairly unconditional, automatic fashion. Numerous studies have shown that stimulus evaluation is driven by fast (e.g., Hermans, De Houwer, & Eelen, 2001) and efficient processes (e.g., Hermans, Crombez, & Eelen, 2000) that are not dependent upon the conscious identification of the instigating object (e.g., Draine & Greenwald, 1998), or the activation of an explicit evaluative processing goal (e.g., Bargh, Chaiken, Raymond, & Hymes, 1996; but see Spruyt, De Houwer, & Hermans, 2009; and Spruyt, Hermans, De Houwer, & Eelen, 2007).

There is also evidence showing that the automatic evaluation of a stimulus has important consequences.

First, it can result in the automatic pre-activation of affectively congruent responses. De Houwer and Eelen (1998), for instance, asked participants to categorize affectively polarized words according to their grammatical category using the response labels ‘positive’ and ‘negative’. They found that participants were quicker to say ‘positive’ to a positive word and ‘negative’ to a negative word, even though the affective value of the word was not task relevant. The affective connotation of the words appeared to automatically activate a response tendency that led to the pre-activation of affectively congruent responses (e.g. responding “positive” to “flower”) as opposed to affectively incongruent responses (e.g. responding “positive” to “gun”). Another paradigm that can be used to capture this consequence is the affective priming paradigm (Fazio, Sanbonmatsu, Powell, & Kardes, 1986; see Klauer & Musch, 2003 for a review). In this paradigm, participants are asked to affectively categorize affectively polarized target stimuli, each of which is preceded by the short presentation of an affectively polarized prime stimulus. Performance is usually better when the prime stimulus and the target stimulus belong to the same affective category (e.g. the words “baby” and “flower”) than when they do not (e.g. the words “murderer” and “flower”). The prime stimulus is thought to pre-activate a response tendency that is affectively congruent or incongruent with the response to the target stimulus and thus affects further responding.

The affective priming paradigm can also capture another consequence of automatic stimulus evaluation, namely effects at the stimulus encoding level. This consequence becomes apparent when the affective priming paradigm is adapted in such a way that participants no longer have to affectively categorize target stimuli but are asked to name them instead. In such a task, the response tendencies activated by the prime stimuli are not part of the response set required to perform the task at hand. Pre-activation of affectively congruent responses can therefore be ruled out as a source for affective priming effects in the naming task. Nevertheless, several researchers did find affective priming effects when employing this task (Bargh, Chaiken, Raymond, & Hymes, 1996; Spruyt et al., 2009; Spruyt, Hermans, De Houwer, and Eelen, 2002; Spruyt, Hermans, De Houwer, Vandromme, & Eelen, 2007; Wentura & Frings, 2008), suggesting that the automatic evaluation of the prime stimulus speeds up the processing of a target stimulus that belongs to the same affective category. On the basis of this finding, it has been argued that the automatic evaluation of a stimulus affects subsequent stimulus encoding.

Finally, the automatic evaluation of a stimulus can exert an influence on the automatic allocation of attention. More specifically, it has been shown that negative or threatening stimuli tend to attract attention (for a review, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Yiend, 2010). Two paradigms often used to measure this attentional bias are the emotional Stroop task and the dot probe task. In the *emotional Stroop task*, participants name the ink color of sequentially presented words. Performance is usually worse when the presented word has a negative meaning than when it is affectively neutral (e.g., Pratto & John, 1991). This emotional Stroop effect is thought to reflect the power of negative, threatening information to draw attention away from the task of naming the color (for a review, see Williams, Matthews, &

MacLeod, 1996). In the *dot probe task* (MacLeod, Mathews, & Tata, 1986), participants are asked to respond to (the location of) a neutral probe stimulus that is presented on one of two possible screen locations. A neutral and a negative stimulus are presented in these locations shortly before the probe presentation. Performance is typically better when the probe appears on the location in which a negative stimulus has been shown, suggesting that the negative stimulus attracts attention to that location. These effects of attentional bias tend to be more pronounced and reliable in high-anxious populations (Bar-Haim, et al., 2007; Fox, Russo, Bowles, & Dutton, 2001; Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2004).

By definition, attentional and other consequences of automatic stimulus evaluation depend on the presence of automatic stimulus evaluation and thus on its enabling conditions. Recent studies conducted at our lab suggest, however, that automatic stimulus evaluation itself is not unconditional but occurs only under certain conditions (Everaert, Spruyt, & De Houwer, 2011; Spruyt, De Houwer, Everaert, & Hermans, 2012; Spruyt, De Houwer, Hermans, & Eelen, 2007; Spruyt et al., 2009). Spruyt et al. (2009) for instance, presented participants with affective priming trials and asked them to name the target words on only 25% of all trials. On the remaining 75% of the trials (hereinafter referred to as ‘induction trials’), one group of participants categorized target words as either “good” or “bad” (the affective group) whereas the second group of participants categorized target words as either “humans” or “objects” (the non-affective group). Affective priming of naming responses was observed in the affective group only. Conversely, participants in the non-affective group displayed non-affective semantic category priming effects only (i.e. better performance when prime and target both denoted a human or an object than when they did not). If stimulus evaluation truly occurs in an unconditional fashion, affective priming of naming responses should have taken place irrespective of which categorization task was performed on the induction trials.

To account for these findings, Spruyt et al. (2009) hypothesized that the semantic analysis of task-irrelevant stimuli is dependent on feature-specific attention allocation (FSAA). Whenever affective stimulus information is selectively attended to, automatic affective stimulus processing of task-irrelevant stimuli is expected to occur. When selective attention is directed to non-affective semantic stimulus information, however, task-irrelevant stimuli are assumed to be processed in terms of the non-affective semantic properties that are selectively attended to. In other words, the affective connotation of a stimulus will be processed in an automatic fashion only if attention is allocated to the affective features of the stimulus. Likewise, non-affective semantic stimulus features will be encoded automatically only if they are attended to.

Several other studies further corroborated this hypothesis. Spruyt, De Houwer, Everaert, and Hermans (2012), for instance, demonstrated that FSAA can affect even the affective processing of (prime) stimuli that are presented below awareness thresholds. Everaert et al. (2011) showed that subtle aspects of the experimental procedure, such as a high valence-proportion (i.e., the proportion of affective stimuli in the environment) can suffice to promote automatic affective stimulus processing (see also, Duscherer, Holender, & Molenaar, 2008).

Because automatic affective stimulus processing is dependent on FSAA, one can expect that attentional and other consequences of automatic evaluation are also contingent upon FSAA. The primary aim of the research reported in this manuscript was to examine whether attentional bias for negative stimuli depends on selective attention towards negative stimulus information. More specifically, we tested the prediction that automatic attentional bias towards negative stimuli is stronger when negative stimulus information is selectively attended to than when non-affective, semantic stimulus information is selectively attended to. Such a result would not only provide further evidence for the importance of FSAA in automatic affective processing but would also question the common assumption that negative stimuli attract attention in an unconditional manner (e.g., Öhman & Mineka, 2001).

A secondary aim of this manuscript was to examine whether FSAA is sufficient to induce an attentional bias effect. According to this hypothesis, automatic attentional biases should occur for any stimulus that is characterized by a feature that is selectively attended to, regardless of whether this feature has an affective connotation or not. In line with this reasoning, prior studies have demonstrated that people show an automatic attentional bias for stimuli that are somehow relevant for them. Emotional Stroop effects, for instance, are typically more pronounced when the words relate to a person's current concerns (e.g. Riemann & McNally, 1995). Likewise, stimuli relevant to a person's current goals evoke an attentional bias in the dot probe paradigm (Vogt, De Houwer, Moors, Van Damme, & Crombez, 2010) and the visual search paradigm (e.g. Folk, Remington, and Johnston, 1992). There is also evidence showing that stimuli that are held in working memory produce an attentional bias in visual search tasks as well (Soto, Hodsoll, Rothstein, & Humphreys, 2008). It is important to point out, however, that each of these effects were stimulus-specific. Vogt et al. (2010), for instance, observed attentional biases towards goal-relevant stimuli (e.g., 'stripe'), but these effects did not generalize to words that were semantically related to the goal (e.g. 'line'). The FSAA account, however, predicts that attentional biases can occur not only for specific stimuli, but for any stimulus that possesses a particular feature that is selectively attended to. Such a finding would also show that the automatic allocation of attention can be biased not only by the relevance of a stimulus as a whole but also by the relevance of one particular stimulus feature or stimulus dimension.

In two studies, we used Spruyt et al.'s (2009) manipulation of FSAA to test its effects on performance in the emotional Stroop task (Experiment 1) and the dot probe task (Experiment 2). To this end, we mixed trials in which participants performed these tasks with so-called induction trials. In the induction trials, a categorization task was performed to encourage participants to selectively attend either to affective or to non-affective stimulus information. In each experiment, one group of participants (the affective group) performed an affective categorization task (i.e., "negative" vs. "not negative"). Another group of participants (the non-affective group) performed a semantic categorization task (i.e., “human” vs. “not human”). As such, participants in the affective groups were encouraged to attend to affective stimulus information whereas participants in the non-affective groups were encouraged to attend to non-affective semantic stimulus information that was relevant for the discrimination between stimuli that did or did not refer to humans. We hypothesized that an attentional bias for negative stimuli would emerge in the affective groups only. In the non-affective groups, we assumed that an attentional bias would take place for stimuli that referred to humans, as the induction task would render them goal-relevant.

EXPERIMENT 1

Methods

Participants

Sixty-six undergraduate students at Ghent University participated in this study (M_{age} = 19.4; 20 men, 46 women). They were given course credit or were paid € 8 for participation. All participants were native Dutch-speakers and had normal or corrected-to-normal vision.

Materials

The stimulus set consisted of 4 word categories, each containing 24 stimuli (96 words in total, see Appendix A). We obtained affective ratings of these words from 19 independent subjects that judged the affective value of each word on a 9-point scale going from negative to positive. The words could denote a neutral human (e.g., observer; $M_{valence}$ = 5.36, *SD* = 0.52), a negative human (e.g., rapist; $M_{valence}$ = 2.13, *SD* = 0.60), a neutral non-human (e.g., building; $M_{valence}$ = 5.26, *SD* = 0.36), or a negative non-human (e.g., grenade; $M_{valence}$ = 1.95, *SD* = 0.56). The mean affective ratings of the negative word categories differed significantly from those of the neutral word categories, *t’s* > 19, *p’s* < .001. There were no significant differences between the mean affective ratings of the two negative word categories, *t*(46) = 1.07, *p* = .29 or the two neutral word categories, *t*(46) < 1. Furthermore, word norms collected by Keuleers, Brysbaert, and New (2010) confirmed that there were no significant differences between the different word categories regarding word length, *t's* < 1.93, *p's* > .060 and log frequency, *t's* < 1.66, *p's* > .103.

We selected nine additional words (see Appendix A) to serve as stimuli in the practice phases. These words were either negative non-human, neutral non-human, or neutral human, with three words for each category.

All words were presented in an Arial, lowercase font with a size of 28 pixels. They could be presented in one of five colors: white, red, green, blue, and yellow. The experiment was run on a computer with an Intel D930 (3.2 GHz) processor connected to a 19 inch monitor with a refresh rate of 100 Hz. We used two input devices to register responses: a voice key that was connected to the computer's parallel port and a two-button response box that was connected to the computer's gameport. The experiment was programmed using Affect 4.0 (Spruyt, Clarysse, Vansteenwegen, Baeyens, & Hermans, 2010).

Procedure

All participants were tested individually in a dimly lit room. They were randomly assigned to either the affective group (*n* = 33) or the non-affective group (*n* = 33). The instructions were presented on the screen but were clarified orally by the experimenter upon request of the participant.

Participants were asked to perform the induction task when a word was presented in a white font and the emotional Stroop task when a word was presented in any other color.

In the affective group, participants were asked to categorize white target words as either "negative" (left button press) or "not negative" (right button press) using the response box. In the non-affective group, participants were asked to categorize these target words as either "human" (left button press) or "not human" (right button press). The emotional Stroop task was identical in both groups. Participants named the ink color of colored target words in the microphone connected to the voice key. The experimenter coded the participants' vocal responses afterwards with the keyboard of the computer. Four keys were assigned for each color and one key was used to code a voice key failure.

A trial started with a 500-ms presentation of a fixation cross in the center of the screen. After an inter-stimulus interval of 500 ms, the target word appeared in one of the five possible colors that indicated which task had to be performed. In all cases, the word disappeared from the screen when the participant gave a response. The inter-trial interval was initiated after the participant's response in the induction task or after the experimenter's coding response in the emotional Stroop task. This inter-trial interval varied randomly between 500 ms and 1500 ms.

Participants were subjected to three practice phases and one experimental phase. In the first practice phase, all participants performed 12 emotional Stroop trials. In the second phase, 12 induction trials were presented. In the third practice phase, 12 trials of each task were randomly intermixed.

Because the use of affectively polarized stimuli can be sufficient to induce selective attention for affective stimulus information (Everaert et al., 2011), the practice stimuli in the non-affective group belonged to the neutral word categories. Likewise, the practice stimuli in the affective group belonged to the non-human word categories. Accordingly, only 6 of the 9 practice stimuli were used in each group.

The experimental phase of the experiment consisted of 48 induction trials and 48 emotional Stroop trials that were randomly intermixed. For each participant separately, the initial set of 96 words was semi-randomly split in two sets of 48 words, each containing an equal numbers of words that belonged to the same word category (neutral human, neutral non-human, negative human, negative non-human). One set of words was used for the induction trials, the other set was used for the emotional Stroop trials. Each word was presented exactly once. The occurrence of different word colors in the emotional Stroop task was counterbalanced across different word categories (i.e., three words of each category in each color).

Results

The analysis was restricted to the data of the emotional Stroop task. Because participants made very few errors (1.24%), reaction-time data were the primary focus of analysis. For the reaction-time analysis, we excluded reaction times of trials with errors and trials in which the voice key was triggered inaccurately (2.94%). To lessen the impact of outlying values we also discarded trials with reaction times that differed more than 2.5 standard deviations from a participant's mean reaction time in a particular condition (1.45%, see Ratcliff, 1993).

For each participant, we calculated the mean Stroop scores for affective stimulus information and non-affective stimulus information. The emotional Stroop score reflected the difference in color naming latency between the negative words and the neutral words. The human Stroop score reflected the difference in color naming latency between the words that denoted a human and the words that did not, regardless of stimulus valence (see Table 1 for the mean latencies).

We ran a 2 (group: affective vs. non-affective) × 2 (stimulus information: affective vs. non-affective) repeated measures ANOVA on the participants' mean Stroop scores. The crucial two-way interaction between group and stimulus information was highly significant, $F(1,64) = 11.00$, $p = .002$, $MSE = 2345$, $f = 0.42$. The main effects of group and stimulus information were not significant, $F(1,64) = 1.89$, $p = .174$, $MSE = 2067$, and $F(1,64) < 1$, respectively.

Table 1.

Mean reaction times and SDs (in ms) in Experiment 1, for each stimulus information type as a function of group.

	Stimulus Dimension							
	Affective				Non-affective			
	Negative		Neutral		Human		Non-Human	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Affective	749	97	721	90	735	94	737	92
Non-affective	739	99	729	93	753	97	716	94

Follow-up analyses confirmed that the emotional Stroop effect was significant only in the affective group, *M* = 28 ms, *F*(1,32) = 11.05, *p* = .002, *MSE* = 2272, *d* = 0.58. In the non-affective group, the emotional Stroop effect was not significant, *M* = 10 ms, *F*(1,32) = 1.51, *p* = 0.228, *d* = 0.29. In contrast, participants in the non-affective group responded significantly slower to words that denoted humans than words that did not, *M* = 37 ms, *F*(1,32) = 22.89, *p* < .001, *MSE* = 1953, *d* = 0.83. Participants in the affective group did not show such an effect, *M* = -2 ms, *F*(1,32) < 1.

Discussion

The results of Experiment 1 are completely in line with the predictions that we derived from the FSAA account.

First, the emotional Stroop effect was stronger and significant only when participants selectively attended to affective stimulus information. When non-affective stimulus information was selectively attended to, no significant emotional Stroop effect was observed. This data pattern is consistent with the idea that automatic attentional biases to negative stimuli depend on selective attention to negative stimulus information. It also shows that negative stimuli do not unconditionally evoke an attentional bias effect. Instead, automatic allocation of attention to negative stimuli depends on the current relevance of negative information.

Second, when participants were encouraged to selectively attend to stimulus information relevant for the discrimination between humans and non-humans, color naming reaction times were consistently slower when a word referred to a human than when it did not. Participants thus exhibited an effect similar to the emotional Stroop effect, but related to the selectively attended, non-affective stimulus information. These effects show that FSAA can induce an automatic attentional bias for non-affective stimuli that share a selectively attended feature.

It should be noted, however, that the processes underlying effects in the emotional Stroop paradigm are currently under debate. Several authors have argued that processes unrelated to the deployment of attention can also account for the emotional Stroop effect (Algom, Chajut, & Lev, 2004; Bar-Haim et al., 2007; De Ruiter & Brosschot, 1994; McKenna & Sharma, 2004; Phaf & Kan, 2007; Yiend, 2010). Yiend (2010), for instance, argued that Stroop effects might reflect a slow-down of response selection rather than attention capture. Furthermore, McKenna and Sharma (2004; see also Algom et al., 2004; Frings, Englert, Wentura, & Bermeitinger, 2010) pointed out that the emotional Stroop effect is at least partially driven by a slow disengagement process that slows down performance on subsequent trials, as opposed to a fast attentional process that slows down performance on the current trial only (see also Phaf & Kan, 2007). For two reasons, however, it seems unlikely that the effects obtained in our study were driven by a slow disengagement process instead of a fast attentional process. First, unlike classical emotional Stroop studies, we presented the different stimulus types randomly within one block. Under such conditions, a slow disengagement process is unable to contribute to the overall effects as the probability that a trial with a negative word or a trial with neutral word would follow a particular trial was equal across all trials. Second, we found a clear effect of stimulus type on current performance only. That is, follow-up analyses revealed that the nature of trial n-1 exerted no influence on the observed effects whatsoever, *F*’s < 1.

Irrespective of this debate, it is important to emphasize that emotional Stroop effects can take place only if the affective meaning of a stimulus is processed. Therefore, our data are in line with earlier reports of our lab showing that FSAA modulates automatic affective stimulus processing. Nevertheless, to further corroborate our claims regarding the modulation of the attentional consequences of automatic stimulus evaluation, we decided to conceptually replicate Experiment 1 using the dot probe task as an attentional bias measure (Macleod et al., 1986).

EXPERIMENT 2

Method

Participants

In this study, 43 undergraduate students at Ghent University participated (M_{age} = 18.8; 36 women, 7 men) in exchange for course credit. All participants were native Dutch-speakers and had normal or corrected-to-normal vision.

Materials

We selected several stimulus sets from the IAPS picture database based on the norm data provided by Lang, Bradley, & Cuthbert (1999). For the dot probe task, we selected 12 pictures for each of four possible stimulus categories: neutral humans ($M_{valence}$ = 5.18, *SD* = 0.43), neutral non-humans ($M_{valence}$ = 5.05, *SD* = 0.31), negative humans ($M_{valence}$ = 2.61, *SD* = 0.56), and negative non-humans ($M_{valence}$ = 2.83, *SD* = 0.33). Hence, a total of 48 pictures were used for the dot probe task. The mean affective ratings of the pictures in each negative category did not differ significantly from one another, $t(22) = 1.14$, $p = .266$. Likewise, the mean affective ratings of the pictures in each neutral category did not differ significantly as well, *t*(22) = 0.84, *p* = .410. The mean affective rating of each negative category differed significantly from the mean affective rating of each neutral category, *t's* > 12, *p's* < .001.

To maximize the manipulation of feature-specific attention allocation, the stimuli used on the induction trials varied only on the stimulus dimension that was task-relevant on the induction trials (see Everaert et al., 2011; Spruyt et al., 2009). In the non-affective group, the stimuli used for the induction trials were 8 affectively neutral humans ($M_{valence}$ = 5.45, *SD* = 0.81) and 8 affectively neutral pictures that did not display humans (non-humans; $M_{valence}$ = 5.28, *SD* = 0.56). In the affective group, the same set of affectively neutral pictures depicting humans was combined with 8 negative pictures of both humans and objects ($M_{valence}$ = 2.69, *SD* = 0.74). The mean affective rating of the negative induction pictures differed significantly from the mean affective ratings of the neutral induction pictures, all *t's* > 7, all *p's* < .001. The mean affective ratings of the pictures in the neutral categories did not differ significantly across categories, *t*(14) < 1.The critical stimuli used for the dot probe task thus were the same for all participants, while the stimuli used in the induction task could be different.

Similar to the selection and the allocation of the practice stimuli in Experiment 1, we selected nine additional pictures to be used in the practice phases. These pictures contained either a neutral human (*n* = 3, $M_{valence}$ = 6.84, *SD* = 0.53), a neutral non-human (*n* = 3, $M_{valence}$ = 6.46, *SD* = 1.17), or a negative object or human (*n* = 3, $M_{valence}$ = 2.44, *SD* = 0.97).

In the non-affective group, the stimuli in the practice phases consisted of neutral human pictures and neutral non-human pictures. In the affective group, these stimuli consisted of negative pictures and the neutral non-human pictures.

All pictures were resized to a width of 264 pixels and a height of 198 pixels. The experiment was run with the hardware and software of Experiment 1.

Procedure

All participants were tested individually in a dimly lit room and were randomly assigned to either the affective group (*n* = 22) or the non-affective group (*n* = 21). They were seated approximately 75 cm from the screen. All instruction were presented on the computer screen but were clarified orally by the experimenter when requested by the participant.

Each trial started with the presentation of three horizontally centered, vertically aligned white rectangles on a black background. Each rectangle was 270 pixels wide and 204 pixels high and subtended visual angles of 7.2° horizontally and 5.5° vertically. The rectangles were presented in such a way that the bottom rectangle and the top rectangle were 7 pixels apart from the middle rectangle. The centers of the top and bottom rectangle subtended a visual angle of 11.3°.

A fixation cross was presented for 500 ms in the center of the middle rectangle. After the presentation of the fixation cross, participants performed the induction task when a picture was presented in the middle rectangle and the dot probe task when no picture was presented in the middle rectangle.

The induction task in the affective group required participants to categorize the target pictures as "negative" or "not negative". In the non-affective group, participants were asked to categorize the picture as either a "human" or not ("not human"). The picture was erased from the screen when the participant uttered a response. A voice key was used to register the response latencies. The experimenter coded the participant's verbal response afterwards, which initiated an inter-trial interval that varied randomly between 500 ms and 1500 ms.

The dot probe task was identical in both groups and was modeled after previous studies of Dewitte, Koster, De Houwer, and Buysse (2007), Vogt, De Houwer, and Crombez (2011), and Vogt, Lozo, Koster, and De Houwer (2011). Two pictures were presented simultaneously in the upper and lower rectangle. After 350 ms, the pictures were erased from the screen and a small square with a diameter of 30 pixels was presented in the center of the upper or lower rectangle. Participants were informed that the pictures were task-irrelevant and were asked to indicate the position of the square with the left or the right key of the response box. The response mappings were counterbalanced across participants. The small square disappeared when the participant responded, after which the randomly varying inter-trial interval was initiated.

Similar to Experiment 1, participants performed 3 practice phases before they started the experimental phase. Participants first completed 12 dot probe trials, followed by 12 induction trials, and then completed the final practice phase in which 12 trials of each task were presented in a random order.

The experimental phase of the experiment consisted of 72 experimental trials and 72 induction trials, presented randomly intermixed. During the dot probe trials, pairs of pictures were presented in such a way that each of the six possible combinations of picture categories were presented equally often and that each picture was presented three times in the experiment. Furthermore, the location of each possible picture category as well as the location of the dot probe were randomized. In sum, there were 24 cells in the design (6 category pairs x 2 picture locations x 2 probe locations) that were presented three times each. The pictures used for the induction task were selected at random (with replacement) from the list of available induction stimuli, with the restriction that each possible stimulus category (negative or human vs. non-negative or non-human) was presented equally often throughout the experiment.

Results

The analysis was restricted to the data of the dot probe trials. On average, participants made few errors (3.46%)[1]. For the reaction time analysis, we ex-

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[1] The analysis of the attentional bias scores of the error percentages yielded no significant results, $F(1,41) < 1.6$, for all main effects and the two-way interaction.

cluded trials with errors, and trials with reaction times that differed more than 2.5 standard deviations from a participant's mean reaction time in a particular condition (2.00%, Ratcliff, 1993).

We calculated participants' mean attentional bias scores for negative pictures by subtracting the mean reaction time of the trials in which the probe appeared on the location of a negative picture from the mean reaction time of the trials in which the probe appeared on the location of a neutral picture. Because the dot probe task is used to measure the attentional competition between a neutral and a negative stimulus (Bar-Haim et al., 2007), the calculation of the attentional bias scores did not include dot probe trials in which two pictures of the same valence were presented. In the same way, we calculated a participant's mean attentional bias towards non-affective stimulus information by subtracting the mean reaction time of the trials in which the probe appeared on the location of a human picture from the mean reaction time of the trials in which the probe appeared on the location of a non-human picture. Trials in which both pictures denoted a human or both pictures did not denote a human were not included in this calculation (see Table 2, for the mean reaction times).

A 2 (group: affective vs. non-affective) × 2 (stimulus information: affective vs. non-affective) repeated measures ANOVA on the attentional bias scores yielded a significant two-way interaction between group and stimulus information, $F(1,41) = 4.45$, $p = .041$, $MSE = 957$, $f = 0.33$. The main effects of group and stimulus information were not significant, $F(1,41) = 1.52$, $p = .223$, $MSE = 469$, and $F(1,41) = 1.97$, $p = .168$, $MSE = 957$, respectively.

As expected, participants in the affective group reacted faster to the probe when it was presented on the location of a negative picture rather than a neutral picture, $M = 11$ ms, $F(1,21) = 6.21$, $p < .05$, $MSE = 410$, $d = 0.53$. No such effect was observed in the non-affective group, $M = -9$ ms, $F(1,20) = 2.21$, $p = .153$, $MSE = 788$, $d = 0.32$. In contrast to our expectation, however, participants in this group did not react faster to the probe when it was on the location of a human picture rather than a non-human picture, $M = -4$ ms, $F(1,20) < 1$. Instead, there was a tendency for attentional bias to occur toward non-human pictures in the affective group, *M* = -13 ms, *F*(1,21) = 3.63, *p* = .070, *MSE* = 974, *d* = 0.40.

Table 2.

Mean reaction times and SDs (in ms) in Experiment 2, for each stimulus information type as a function of group.

	Stimulus Dimension							
	Affective				Non-affective			
	Congruent		Incongruent		Congruent		Incongruent	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Affective	452	88	463	101	463	99	450	86
Non-affective	437	73	428	68	432	63	428	73

Note. Affectively congruent cells represent trials in which the dot was presented on the location in which a negative picture was presented previously. Non-affectively congruent cells represent trials in which the dot was presented on the location in which a human picture was presented previously.

Discussion

The aim of the present experiment was to demonstrate that attentional biases measured with the dot probe task are modulated by FSAA. We therefore asked participants to perform the dot probe task and encouraged one group of participants to selectively attend to affective stimulus information and another group to selectively attend to non-affective, semantic stimulus information.

In line with the FSAA account, the attentional bias towards negative images was stronger when participants were encouraged to attend affective stimulus information than when they were encouraged to attend to semantic stimulus information. Moreover, a significant attentional bias was observed only in the former condition. We also investigated the secondary hypothesis that FSAA can induce an automatic attentional bias. In contrast with this hypothesis, we did not observe a significant attentional bias towards pictures that depicted humans when participants were encouraged to attend to stimulus information relevant for the discrimination of humans from non-humans. We are currently in the dark as far as a possible explanation for the absence of this effect is concerned. Nevertheless, one should keep in mind that the absence of the effect is a null finding that could be due to a lack of statistical power.

GENERAL DISCUSSION

Recent studies suggest that automatic affective stimulus processing does not occur unconditionally but instead is dependent on FSAA (Everaert et al., 2011; Spruyt et al., 2007, 2009). We hypothesized that FSAA should affect not only affective stimulus processing per se, but also the consequences of affective stimulus processing. In this paper we focused on one of these consequences, namely attentional bias towards affective stimuli.

We conducted two experiments in which we intermixed emotional Stroop trials (Experiment 1) or dot probe trials (Experiment 2) with induction trials. The induction trials were used to encourage one group of participants to selectively attend to affective stimulus information (the affective groups) and another group to selectively attend to non-affective, semantic stimulus information (the non-affective groups). In these trials, participants categorized stimuli as “negative” or “not negative” in the affective groups, or as “human” or “not human” in the non-affective groups.

The results of both Experiment 1 and Experiment 2 support the idea that attentional bias to negative stimuli depends on FSAA. Emotional Stroop effects and dot probe effects for negative stimuli were stronger in the affective groups than in the non-affective groups and significant only in the affective groups. These results not only provide further evidence for the importance of FSAA in automatic affective processing but also reveal that negative stimuli do not draw attention in an unconditional manner. Instead, automatic attentional biases for negative stimuli depend on the extent to which negative information is currently relevant.

The data of Experiment 1 further suggested that FSAA can induce attentional bias effects. A significant slowdown in reaction time was observed for words that denoted humans when participants were encouraged to attend to stimulus information relevant for the discrimination between humans and nonhumans. The results of Experiment 2, however, did not completely parallel the results of Experiment 1. In the non-affective group of Experiment 2, no significant attentional bias towards humans was observed. At present, we do not have a good explanation for these seemingly inconsistent effects except for the possibility that the null finding in Experiment 2 was due to a lack of statistical power.

Apart from demonstrating the impact of FSAA on automatic attentional biases for affective stimuli, the current experiments also conceptually replicated and extended earlier findings showing that the task relevance of a stimulus can modulate attentional bias. For example, Folk et al. (1992) convincingly demonstrated that a task relevant stimulus seems to draw attention in a task similar to the dot probe paradigm. Furthermore, these effects were also found for complex stimuli that were relevant to a person's current goal (Vogt et al., 2010). However, most of these particular effects are highly specific and limited to only those stimuli that were actually used in the task itself. We contribute to this line of research by applying it to any stimulus that has a task relevant feature. The stimuli on which the induction task was performed, were not even used in the emotional Stroop task or the dot probe task and vice versa. The effects we observed were anything but stimulus specific and thus demonstrated the generality of the impact of FSAA on attentional biases. Moreover, they demonstrate for the first time that the relevance of a stimulus *feature* can automatically bias attention for that feature. The latter conclusion should, however, be treated cautiously as we did not observe an attentional bias effect for the (relevant) non-affective feature in the non-affective condition of Experiment 2.

Although we found attentional bias to negative stimuli only when FSAA was explicitly directed to affective stimulus information, there is ample evidence showing that attentional bias effects can be obtained in the absence of explicit manipulations of FSAA too. The question thus arises how one can reconcile these findings with our claim that attentional bias effects are critically dependent upon FSAA. We see at least two different ways in which attention assignment to affective stimulus information can occur in the absence of explicit manipulations of FSAA. First, the blatant use of affective stimuli might be sufficient to encourage participants to attend to affective stimulus information (see Everaert et al., 2011, for data supporting this assumption). Second, it is perfectly reasonable to assume that people are chronically inclined to attend to affective stimulus information because it has a survival value to do so. Within this framework, attentional bias towards negative stimuli is assumed to occur unless attention is explicitly directed away from affective stimulus information. So even though FSAA might be directed towards affective stimulus information by default, it can be shifted flexibly towards other, currently relevant sources of stimulus information. Our account predicts that automatic stimulus evaluation of task-irrelevant stimulus sources will not occur under such circumstances. Interestingly, in persons with heightened anxiety or clinical anxiety, switching off the automatic stimulus evaluation might be more difficult to achieve.

This latter point is compatible with a bulk of findings showing considerably larger attentional biases for negative stimuli in anxious populations (Bar-Haim et al., 2007). Note, however, that our framework makes no predictions whatsoever concerning the precise direction of attentional deployment once the affective connotation of a stimulus has been processed. For example, some studies have shown that acute stress can lead to an attentional bias *away* rather than towards negative stimuli (Bar-Haim et al., 2010; Wald et al., 2011). Directing attention away from a negative stimulus still requires one to process the valence of this stimulus first. Our framework concerns the initial stimulus evaluation processes, not the subsequent processes that come into play once the valence of a stimulus has been established.

It is important to stress that we do not claim that automatic affective stimulus processing and its consequences are not “truly” automatic. As Moors and De

Houwer (2006) pointed out, automaticity is not an all-or-none phenomenon. That is, different automaticity features do not always co-occur and should therefore be studied independently. It would thus not be warranted to conclude that affective processing is non-automatic just because it is dependent on a certain precondition (i.e., FSAA). We do claim, however, that automatic affective stimulus processing and attentional bias for negative stimuli do not occur in an *unconditional* manner but depend on FSAA.

To summarize, we examined the extent to which automatic attentional biases, are modulated by feature-specific attention allocation. Attentional bias towards negative stimuli was found under conditions that encouraged participants to assign attention to affective stimulus information only. In addition, our findings suggest that selective attention for particular non-affective stimulus information can result in an attentional bias for stimuli that are characterized by that feature. We conclude that attentional biases, as consequences of automatic (affective) stimulus processing, are fairly malleable and dependent on FSAA.

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APPENDIX A

WORDS USED IN EXPERIMENT 1

Practice words (English translations between brackets)

Neutral non-human words. raadsel (riddle); populier (poplar); tafel (table).

Neutral human words. concierge (janitor), inwoner (resident), getuige (witness).

Negative non-human words. marteling (torture); incest (incest); agressie (aggression).

Experimental words (English translations between brackets)

Neutral non-human words. aardappel (potato); kalender (calendar); telefoon (telephone); venster (window); bladzijde (page); klavier (keyboard); gebouw (building); bloempot (flowerpot); balpen (ballpoint); programma (program); papier (paper); tomaat (tomato); smoking (smoking); trompet (trumpet); hazelnoot (hazelnut); achtergrond (background); website (website); rugzak (backpack); voetpad (sidewalk); scherm (screen); kassa (cash register); trein (train); vliegtuig (airplane); kladblok (scratch-pad).

Neutral human words. bediende (employee); fietser (cyclist); arbeider (workman); burger (civilian); tuinier (gardener); bewoner (inhabitant); spreker (speaker); waarnemer (observer); secretaris (secretary); beambte (functionary); handelaar (trader); assistent (assistant); bassist (bassist); werknemer (employee); reiziger (traveler); chauffeur (driver); bezoeker (visitor); stedeling (townsman); aanwezige (person present); bakker (baker); toerist (tourist); leerling (pupil); collega (colleague); kassier (cashier).

Negative non-human words. kakkerlak (cockroach); infectie (infection); tandpijn (toothache); braaksel (vomit); gezwel (swelling); misdaad (crime); ongeluk (accident); zelfmoord (suicide); geweer (rifle); bommen (bombs);

granaat (grenade); tumor (tumor); slachting (slaughtering); kanker (cancer); afpersing (extortion); executie (execution); verminking (mutilation); oorlog (war); slijm (slime); lijfstraf (corporal punishment); wonde (wound); afval (waste); bedrog (deceit); ziekte (illness).

Negative human words. neonazi (neo-Nazi); dief (thief); racist (racist); sadist (sadist); lafaard (coward); dealer (drugs dealer); debiel (moron); pedofiel (pedophile); moordenaar (murderer); schizofreen (schizophrenic); gangster (gangster); verliezer (loser); tiran (tyrant); vandaal (vandal); egoïst (egoist); psychopaat (psychopath); hooligan (hooligan); pestkop (bully); pooier (pimp); imbeciel (imbecile); vijand (enemy); leugenaar (liar); verkrachter (rapist); hoer (whore).

APPENDIX B

IAPS PICTURES USED IN EXPERIMENT 2

Practice pictures

Neutral non-human pictures. 1450, 5660, 7004.

Neutral human pictures. 2500, 2501, 2560.

Negative pictures. 1200, 9040, 9622.

Experimental pictures used in the dot probe task

Neutral non-human words. 5395, 5535, 5740, 5900, 7002, 7006, 7009, 7025, 7080, 7211, 7235, 7705.

Neutral human words. 2190, 2214, 2215, 2372, 2383, 2480, 4250, 4605, 5875, 7550, 8260, 9070.

Negative non-human words. 1050, 1052, 1220, 1274, 1300, 6800, 9280, 9340, 9373, 9561, 9611, 9630.

Negative human words. 2053, 2120, 2130, 2276, 2750, 2900, 3022, 3300, 6213, 6250, 8230, 9530.

Experimental pictures used in the group-specific categorization task

Neutral non-human pictures. 1670, 5500, 7040, 7190, 7224, 7285, 7491, 7710.

Neutral human pictures. 2280, 2385, 2485, 2487, 2570, 2620, 2850, 8465.

Negative pictures. 1022, 1120, 2692, 7380, 9041, 9290, 9570, 9830.

CHAPTER 3

FEATURE-SPECIFIC ATTENTION OVERRULES AUTOMATIC ORIENTING TO EMOTIONAL STIMULI [1]

Emotional stimuli are generally thought to be processed in an automatic, unconditional fashion. We demonstrate that an unexpected emotional stimulus evokes amplitude-variations of the P3a (an ERP marker of automatic attention orienting) when attention is directed to emotional stimulus properties but not when a non-emotional stimulus feature is attended to. We conclude that automatic emotional stimulus processing is dependent on top-down attention control mechanisms.

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[1] Based on Everaert, T., Spruyt, A., Rossi, V., Pourtois, G., & De Houwer, J. (2012). *Feature-specific attention overrules automatic orienting to emotional stimuli.* Manuscript in preparation.

FEATURE-SPECIFIC ATTENTION OVERRULES AUTOMATIC ORIENTING TO EMOTIONAL STIMULI

It is commonly acknowledged that emotional stimuli are processed in an unconditional, bottom-up fashion (Vuilleumier, 2005; Zajonc, 1984). Not only has this assumption been corroborated by empirical evidence, it is also an intuitively appealing idea as the swift detection of emotionally relevant stimuli is highly beneficial to survival. Moreover, this mechanism is thought to be dysfunctional or overactive in a wide range of psychopathologies.

Recent studies suggest, however, that automatic emotional stimulus processing critically depends on feature-specific attention allocation (Spruyt, De Houwer, Everaert, & Hermans, 2012; Spruyt, De Houwer, & Hermans, 2009; Spruyt, De Houwer, Hermans, & Eelen, 2007). Specifically, we repeatedly found automatic emotional stimulus processing to occur under conditions that provoke selective attention to emotional stimulus information only. Conversely, when attention was directed to non-emotional semantic stimulus information, clear effects of automatic non-emotional stimulus processing emerged whereas automatic emotional stimulus processing was virtually abolished.

In these studies, however, emotional stimulus processing was measured at the behavioral level only. It thus remains to be seen whether these effects reflect a genuine modulation of automatic emotional stimulus processing or merely reflect a performance effect instead. To resolve this issue, we examined the impact of feature-specific attention allocation on both automatic emotional and non-emotional stimulus processing at the neural level, using EEG measurements.

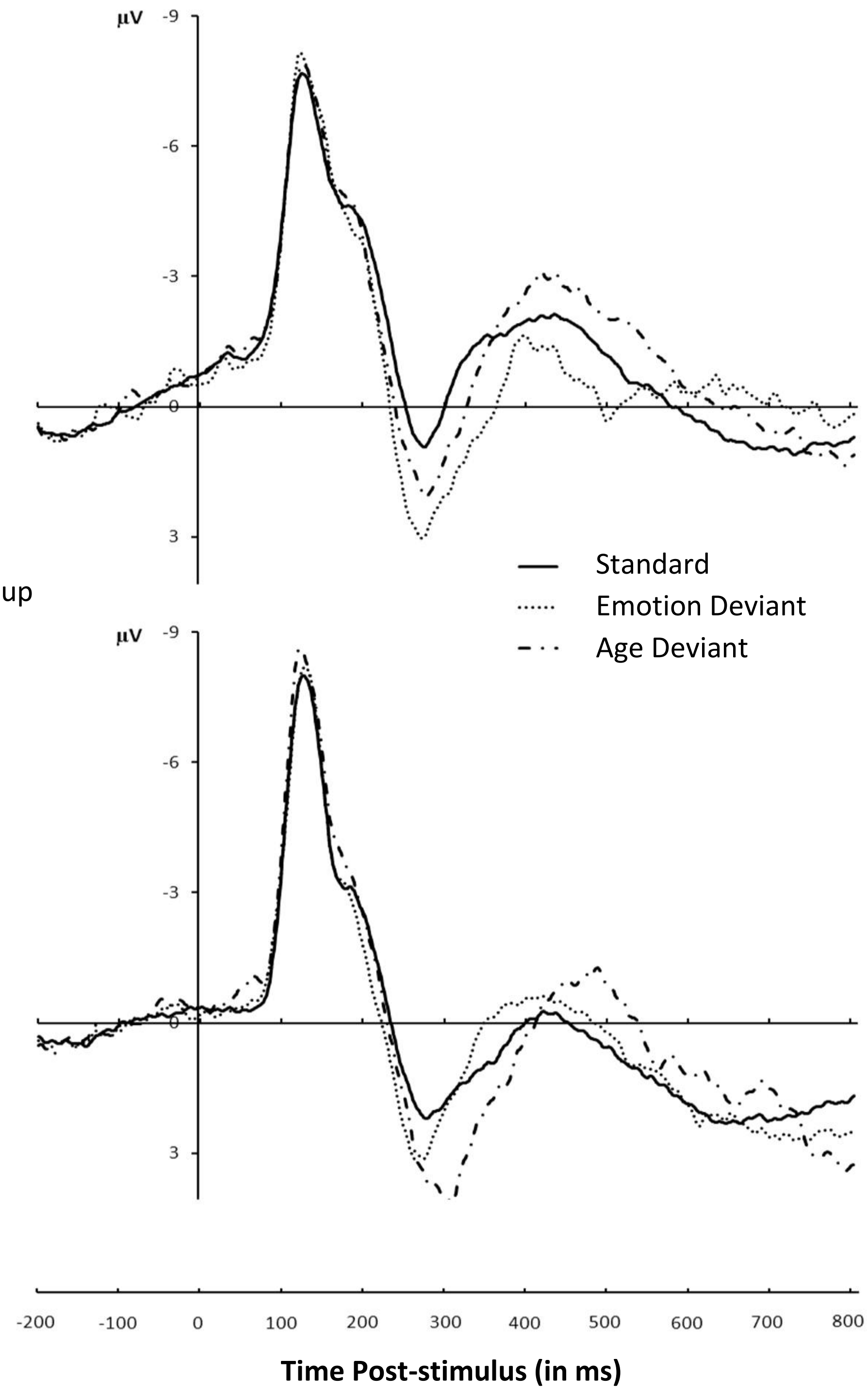
We opted to use an oddball study, in which unexpected (deviant) stimuli presented in a sequence of expected (standard) stimuli evoke an automatic orienting response, reflected by a fronto-central positive deflection (P3a) peaking 250-350 ms post-stimulus onset (Hermann & Knight, 2001; Polich, 2007). This

P3a deflection seems to be sensitive especially to oddball stimuli that are emotionally different from the standard stimuli (Campanella et al., 2002).

We advocate, however, that automatic orienting to both unexpected emotional stimuli and unexpected non-emotional stimuli depends on feature-specific attention allocation. To test this hypothesis, we used an adaptation of the oddball paradigm in which participants were presented with series of faces of middle-aged persons with a neutral facial expression. We refer to these faces as standard stimuli. Occasionally, one of four types of deviant stimuli were presented: middle-aged happy, middle-aged sad, young neutral, and old neutral faces. To manipulate attention, participants were asked to respond to one of the four types of deviant faces. In the emotion group, the go-stimuli were faces with a happy or sad expression. Hence, participants in this group directed their attention to the emotional nature of the facial expression. In the age group, the go-stimuli were young or old faces with a neutral expression. This required attention allocation to the age of the faces. In each condition, there was one task-relevant deviant and two task-irrelevant deviants. A deviant is said to be task-relevant if it deviates from the standard stimuli on the same dimension (emotion or age) as the go-stimulus. For instance, if the go-stimuli were happy faces, sad faces were task-relevant deviants whereas young and old faces were task-irrelevant deviants.

We predicted that the P3a for task-relevant emotional deviants would be bigger than that for task-irrelevant emotional deviants. For instance, the P3a to a deviant sad face should be smaller when participants are asked to detect young or old faces than when their task is to detect happy faces. Similarly, we predicted the automatic processing of non-emotional features to depend on attention allocation too. That is, we expected the P3a for young and old deviant stimuli to be larger when they are task-relevant than when they are task-irrelevant.

Task-relevant deviants evoked a conspicuous positive component that reached its maximal amplitude over medial prefrontal sites 220-400 ms post-stimulus onset (see Figure 1 and Figure 2). These electrophysiological properties (amplitude, latency, polarity, and topography) are consistent with a genuine P3a deflection.


a) Emotion group

b) Age group

Figure 1. *Grand average waveforms at the Fpz electrode and its 5 surrounding electrodes for standard stimuli, emotion deviants, and age deviants in the emotion group (a) and the age group (b).*

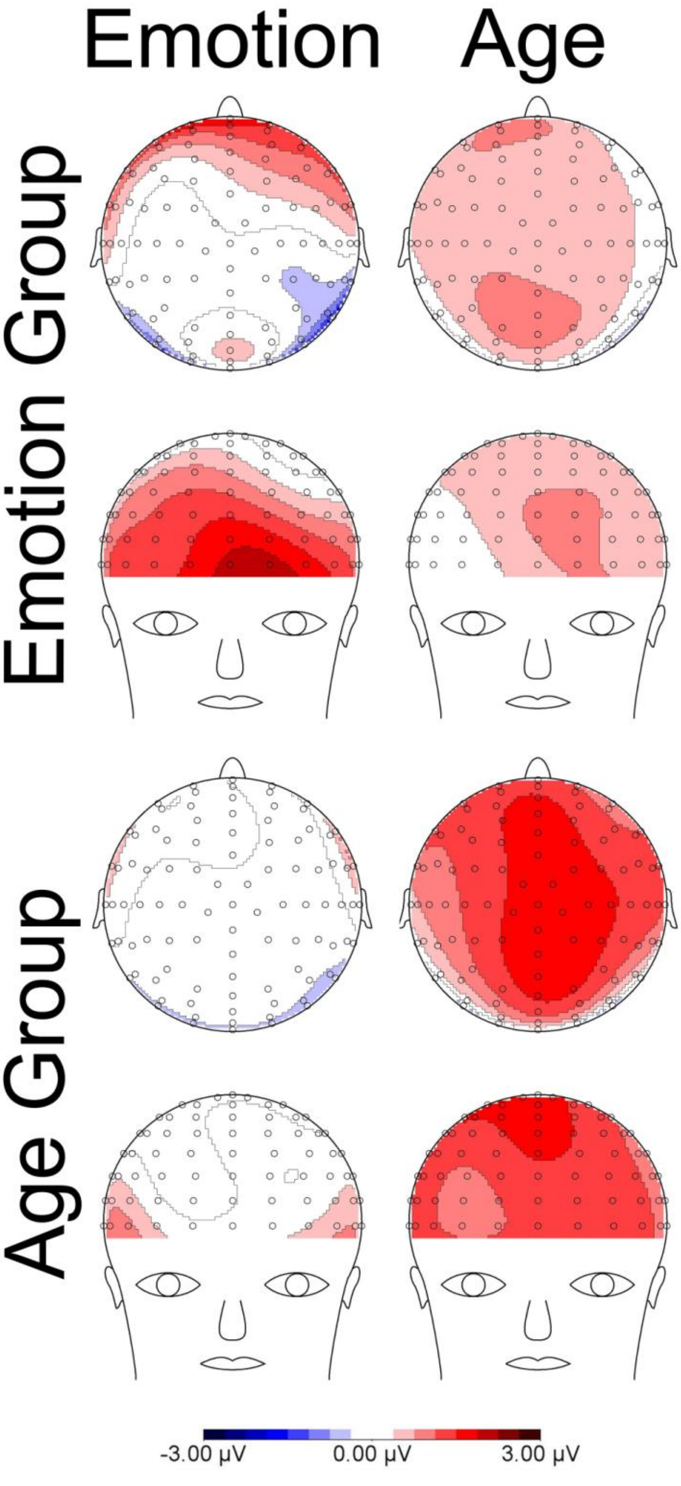


Figure 2. *Topographical maps associated with the difference wave at 220-400 ms, representing the differences between the deviants and the standard faces.*

Conform our prediction, analyses revealed a main effect of task-relevance (*P* = .017) that wasn’t qualified by a two-way interaction with group (*P* = .996). A task-relevant deviant generated a significant P3a (*P* = .002) whereas task-irrelevant deviants did not (*P* = .49). The absence of the two-way interaction suggested that task-relevance affected automatic orienting to emotional and age deviants to the same extent. Crucially, emotional deviants seemed to evoke a significant P3a only when they were task-relevant (*P* < .001), but not when they were task-irrelevant (*P* = .949). Likewise, task-relevant age deviants evoked a tendency towards a P3a (*P* = .129) while task-irrelevant age deviants didn't (*P* = .303). Additional reference-free topographical analyses based on a conservative estimate of the global field strength corroborated this finding (Supplementary Results).

Behavioral results revealed no significant difference in speed (reaction times) across groups for the overt detection of the task-relevant deviants. However, in line with the P3a data, participants did make more false alarms in response to task-relevant deviants as compared to task-irrelevant deviants (Supplementary Results).

Our results provide direct neurophysiological evidence for a strong modulation of automatic emotional stimulus processing by feature-specific attention allocation, thus corroborating earlier behavioral studies (Spruyt et al., 2007, 2009, 2012). While some accounts of emotional processing advocate it is dependent on attention towards the stimulus (Pessoa, 2005), our account implies that emotional stimulus processing is critically dependent on attention towards specific stimulus dimensions. This framework proposes that the feauture-specific direction of attention is of crucial importance but not necessarily cognitive capacity, spatial attention, or awareness. Specifically, automatic emotional stimulus processing can take place when little cognitive resources are available and even when the stimulus is presented peripherally or subliminally, provided emotional stimulus information is selectively attended to. In line with this account, behavioral evidence has been found for subliminal emotional stimulus processing when affective stimulus information was selectively attended to (Spruyt et al., 2012).

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SUPPLEMENTARY METHOD SECTION

Participants

Thirty-three volunteers with normal or corrected-to-normal vision were paid € 20 to participate in this study. Six subjects were excluded from the analyses because their error percentages exceeded 20% in at least 1 cell of the design. The final sample therefore consisted of 27 participants (M_{age} = 21.8 years, 5 males, 2 left-handed).

Stimuli and Materials

Facegen software (http://www.facegen.com) was used to create artificial faces and controlled variations of these faces. We randomly generated 32 faces, of which 5 variations were created: a neutral, 43-year-old face; a sad, 43-year-old face; a happy, 43-year-old face; a neutral, 15-year-old face; and a neutral, 65 year-old-face (for an illustration, see Supplementary Figure 1).

Supplementary Figure 1. *Selection of 2 faces used in this study, with their corresponding variations in emotion and age.*

Consequently, the faces presented in the experiment could either be standard, happy, sad, young, or old. We thus used 160 different pictures of faces as stimuli.

The settings used to generate the variations of the faces were piloted to ensure that the differences between the standard faces and the deviant faces were as comparable as possible. The pictures of the face stimuli measured 235 × 215 px, and were presented in the center of a 19-inch CRT monitor with a refresh rate of 100 Hz and a resolution of 800 × 600 px.

Procedure

Participants were seated in a dimly-lit room and were randomly assigned to one of two between-subjects conditions. Participants in the Emotion Group (*n* = 13) read instructions stating that the experiment aimed at investigating emotion perception, while participants in the Age Group (*n* = 14) read instructions that revealed the aim of the experiment to be the investigation of age perception. They were asked to press the space bar with their dominant hand whenever a relevant face appeared. Within each block only one of the two emotions in the Emotion Group and one of the two ages in the Age Group required a response.

After reading the instructions, participants performed 2 training blocks of 20 trials each, and 12 experimental blocks of 100 trials each. The stimuli presented in each block consisted of 80% standard faces, while the other face types were presented 5% of all times. A subset of the faces was assigned to each block, these subsets were the same for each participant. For each training block, one of the 32 randomly generated faces and its variations were used. In the experimental blocks, 5 faces of the 32-face stimulus set were used together with their variations.

A trial consisted of the central presentation of a face that remained on screen until a response was given or 1500 ms elapsed. Afterwards, an inter-trial interval was initiated that varied randomly between 300 ms and 600 ms.

EEG acquisition and statistical analysis

Participants were fitted with an elastic cap to allow for the recording of the EEG through 128 Ag/AgCl electrodes that were distributed according to the Bio-

Semi ABCD positioning system (Biosemi Active Two System, http://www.biosemi.com). The signal was referenced online to a CMS-DRL ground which drives the subject's average potential as close as possible to the reference voltage of the amplifier (i.e. the amplifier zero). Additionally, 2 electrodes linking the mastoids were used to reference the data off line and 4 electrodes served to monitor vertical and horizontal eye movements. EEGs were digitized at 512 Hz and were band-pass filtered off line between 0.016 and 70 Hz. An additional notch filter centered around 50 Hz reduced AC interference.

Off line computations were performed with Brain Vision Analyzer 2.0 (Brain Products, GmbH, Munich, Germany). Segmentation was performed relative to stimulus onset with an interval ranging from 100 ms before to 1500 ms after stimulus onset. We corrected for eye-blink artifacts using the standard algorithm of Gratton, Coles, and Donchin (1983). Each segment was baseline corrected to the 100 ms pre-stimulus onset interval. Residual artifacts were semi-automatically detected with a ± 75 µV criterion relative to the baseline, after which their segments were deleted. Grand average waveforms were calculated separately for each Stimulus Type (standard face vs. emotionally deviant face vs. age deviant face) of each Group (Emotion vs. Age).

Based on visual inspection and previous research (a.o. Polich, 2007), the P3a component was identified as the most positive peak that occurred between 220 and 400 ms post-stimulus and was maximal on prefrontal sites. The P3b was defined as a positive peak occurring between 400 and 800 ms after stimulus onset that was maximally on parietal sites. Difference scores were calculated by subtracting the mean amplitudes of the average waveform associated with the standard faces from the mean amplitude of the average waveform associated with the other face types (emotionally deviant faces or age deviant faces that could or could not be task relevant). These scores were used as dependent variables in the subsequently performed repeated measures ANOVAs and *t*-tests.

SUPPLEMENTARY RESULTS

Behavioral Results

Reaction-time data were analyzed after exclusion of outlying latencies (3.3%). Cut-off boundaries were defined as being 2.5 standard deviations above and below the participants mean latency in a particular condition (Ratcliff, 1993). The following reaction-time analysis revealed no significant effects (Supplementary Table 1).

An analysis of the number of correctly identified target faces (see Supplementary Table 1) revealed that participants made more correct identifications for sad target faces than for happy target faces, *t*(13) = 2.38, *p* < .05, *d* = 0.66. No other differences with regard to the number of correct hits reached significance, all *t*'s < 1.65.

Supplementary Table 1.

Mean RTs (in ms), Percentage misses, and respective SDs to target faces.

	Group							
	Emotion				Age			
	Happy		Sad		Young		Old	
Dependent variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Response latencies	674	69	689	68	677	74	671	68
Percentage misses	7.6	4.8	2.6	4.3	5	3.6	5	4.8

A 2 (group: emotion vs. age) × 2 (dimension: emotion vs. age) × 2 (face type: young or sad vs. old or happy) repeated measures ANOVA on the participants' false alarm rates (Supplementary Table 2) revealed a significant main effect of dimension, *F*(1,25) = 5.76, *p* < .05, *MSE* = 0.08, *f* = 0.48, indicating more false alarms were made to emotional deviants. Importantly, a significant interaction between condition and dimension showed that more false alarms were made towards task-relevant deviants than to task-irrelevant deviants, $F(1,25) = 12.76$, $p < .01$, $MSE = 0.08$, $f = 0.71$.

Supplementary Table 2.

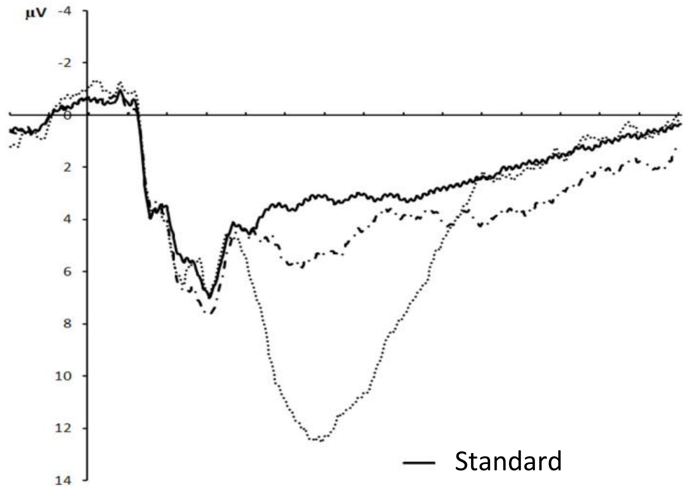
Percentages (and SDs) of false alarms for each deviant type for each group

	Dimension							
	Emotion				Age			
	Happy		Sad		Young		Old	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Emotion	4.1	3.1	3.6	4.8	0.3	1	0.6	1.9
Age	1.9	1.3	0.1	0.4	2.3	4.6	1	1.6

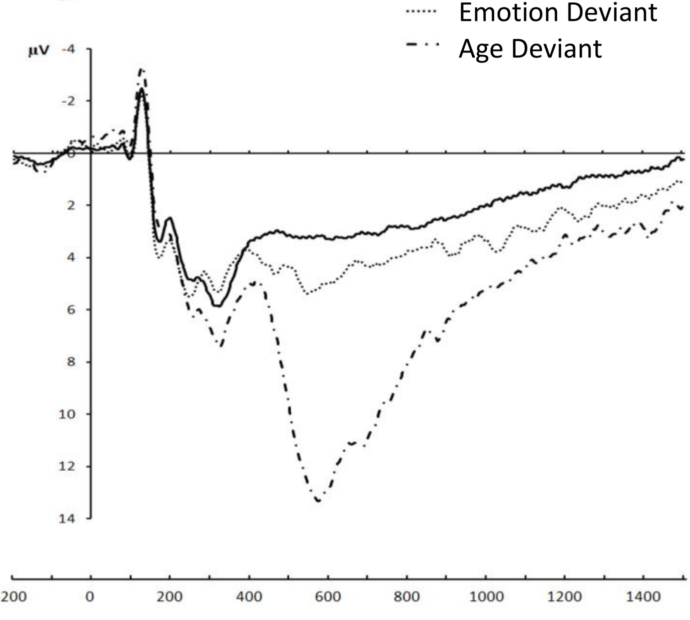
ERP Results

Inspection of the averaged epochs revealed a peak that occurred roughly between 220 ms and 400 ms post-stimulus and was maximal on prefrontal sites. The location in time and space of this peak, relative to the later and more parietal P3b component, suggests that this peak corresponds to the P3a. Further analyses were restricted to the electrode that corresponded to C17/Fpz and its surrounding 5 electrodes. Difference scores were calculated by subtracting the mean amplitudes that corresponded to standard stimuli from the mean amplitudes that corresponded to the faces that deviated in age or emotion. A 2 (group: emotion vs. age) × 2 (deviant type: emotion vs. age) repeated measures ANOVA on these scores yielded a significant interaction, $F(1,25) = 6.61$, $p = .017$, $MSE = 2.48$, $f = 0.51$. This interaction indicated that task-relevant deviant faces produced a significant P3a, $F(1,25) = 12.62$, $p = .002$, $MSE = 4.62$, $d = 0.28$, while task-irrelevant deviant faces did not, $F < 1$. The same pattern of results emerged when peak amplitudes were used as dependent variables in the ANOVA. Again, a significant interaction was obtained, $F(1,25) = 5.52$, $p = .027$, $MSE = 3.74$, $f = 0.47$, showing greater peak amplitudes for task-relevant deviant faces than task-irrelevant deviant faces. Emotional deviants evoked a significant P3a when they were task relevant, *F*(1,12) = 21.94, *p* = .0005, *MSE* = 1.88, *d* = 1.30, but not when they are task-irrelevant, *F* < 1. Concurrently, there was a tendency for age deviants to evoke a P3a when they were task-relevant, *F*(1,13) = 2.63, *p* = .128, *MSE* = 7.15, *d* = 0.43, that was not present when they were task-irrelevant, *F*(1,13) = 1.16, *p* = .303, *MSE* = 5.20, *d* = .30. Similar effects were found on the P3b, which was defined as the peak residing on parietal sites between 400 ms and 800 ms after stimulus onset (see Supplementary Figure 2).

a) Emotion group



b) Age group

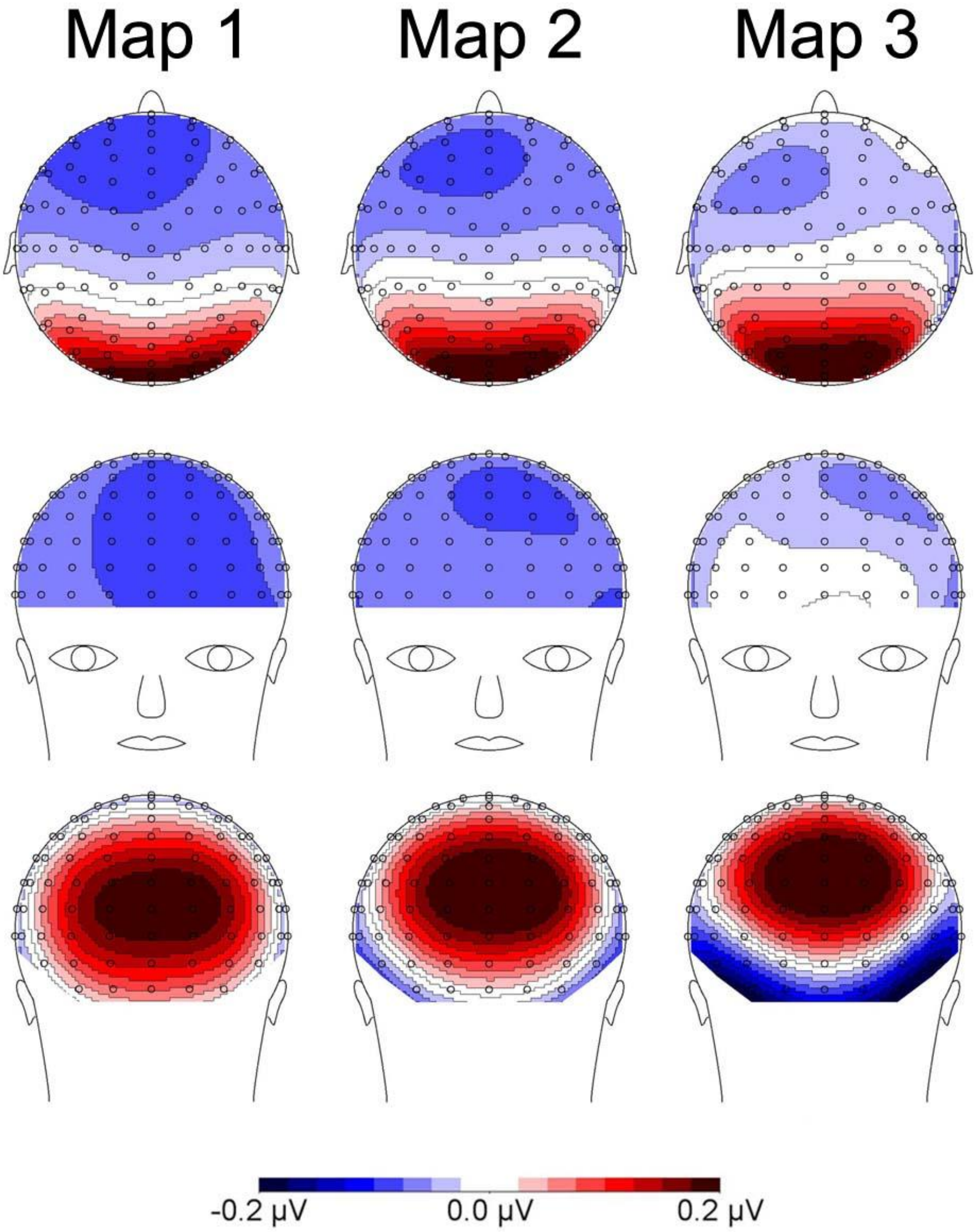


Time Post-stimulus (in ms)

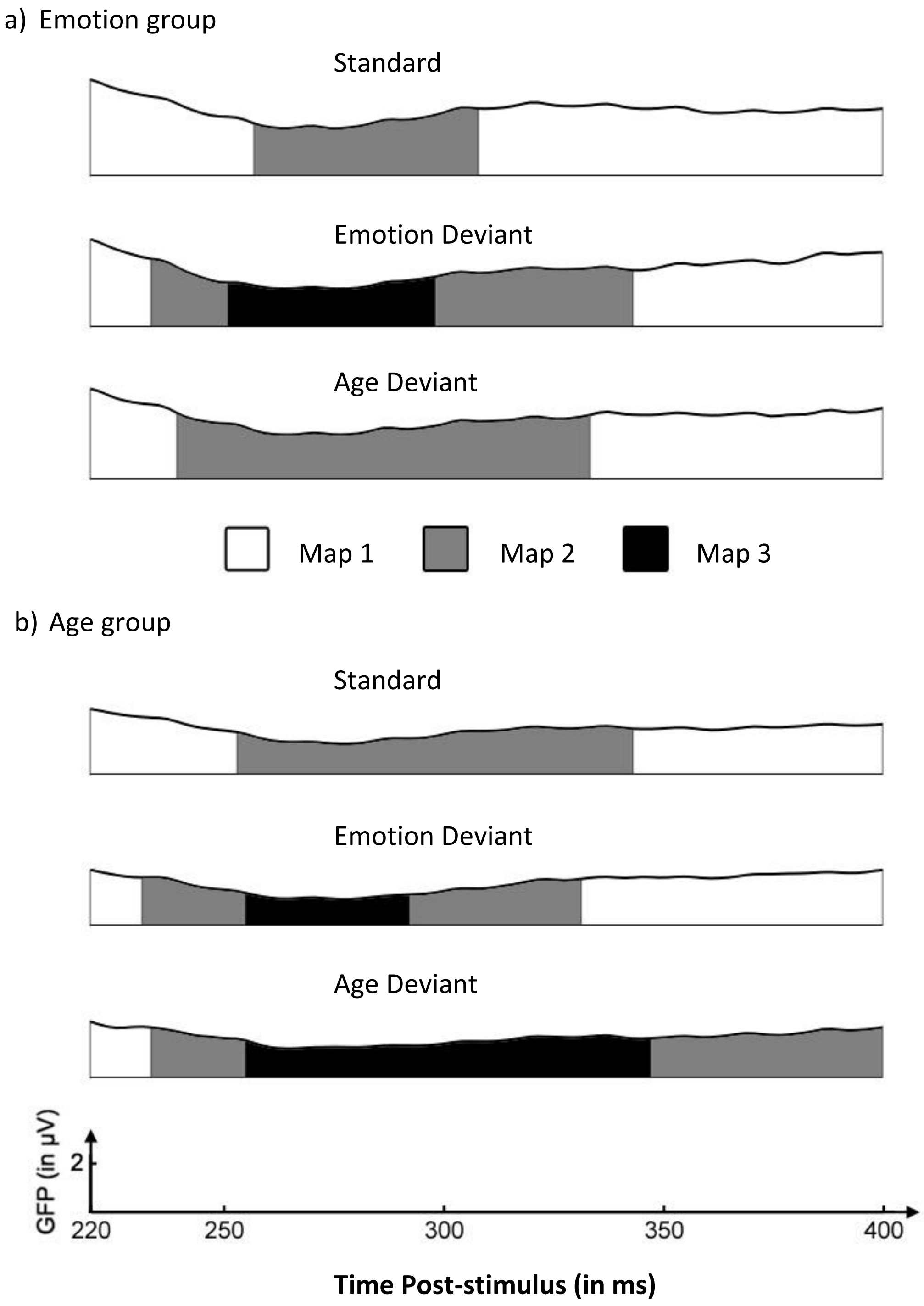
Supplementary Figure 2. *Grand average waveforms at the Pz electrode and its 5 surrounding, more posterior electrodes for standard faces, emotion deviants, and age deviants for the emotion group (a), and the age group (b).*

Analyses on the P3b were restricted to 6 electrodes (A19/Pz and its 5 surrounding, more posterior electrodes) and difference scores were calculated the same way they were calculated when analyzing the P3a. A 2 (group: emotion vs. age) × 2 (deviant type: emotion vs. age) repeated measures ANOVA revealed a significant interaction between the 2 factors only, $F(1,25) = 48.49$, $p < .0001$, $MSE = 7.12$, $f = 1.39$. All deviants evoked a significant P3b, all $F's > 4.69$. However, the P3b amplitude was higher for task-relevant deviants than for task-irrelevant deviants, both for emotional deviants and age deviants, $F(1,25) = 28.21$, $p < .0001$, $MSE = 6.42$, $d = 1.42$, and $F(1,25) = 13.95$, $p < .001$, $MSE = 11.77$, $d = 2.07$, respectively.

In a following step we performed a topographical analysis using the Cartool program (http://brainmapping.unige.ch/cartool) on the EEG data. The grand average EEG waves were segmented into a small number of topographical maps by means of the K-means clustering algorithm. When the clustering algorithm was limited to the temporal interval in which the P3a occurred, a 3-map-solution (see Supplementary Figure 3 and 4) emerged that explained 95.80% of the total variance and was considered the best possible trade-off between data reduction and variance accounted for. Visual inspection suggested map 3 to be related to the P3a due to its topography, marked by relatively more frontal positivity than the other maps (see Supplementary Figure 3). In a subsequent step the maps were fitted back to the individual subjects' data. When the Global Field Power (GFP) of the fitted maps was entered in a 2 (group: emotion vs. age) × 2 (map: map 2 vs. map 3) × 2 (deviant: emotion vs. age) repeated measures ANOVA, a significant three-way interaction between group, map and deviant was observed, $F(1,25) = 5.14$, $p = .032$, $MSE = .01$, $f = 0.61$. When broken down across maps, a significant two-way interaction between group and deviant was observed for Map 3 only, $F(1,25) = 15.90$, $p < .001$, $MSE = 0.73$, $f = 0.78$. This interaction revealed that the mean GFP was higher for task-relevant deviants than for task-irrelevant deviants. This difference was confirmed at the dimension-specific level of the deviants albeit marginally significant, $F(1,25) = 2.91$, $p = .101$, $MSE = 1.82$, $d = 0.66$, for emotional deviants, and *F*(1,25) = 3.03, *p* = .094, *MSE* = 2.10, *d* = 0.67, for age deviants . No such interaction was found upon inspection of Map 2, *F* < 1.



Supplementary Figure 3. *The maps that were extracted using Cartool (http://brainmapping.unige.ch/cartool).*



Supplementary Figure 4. *The temporal distribution of the extracted maps and their associated Global Field Power.*

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CHAPTER 4

FEATURE-SPECIFIC ATTENTION ALLOCATION AFFECTS EMOTIONAL STIMULUS REPRESENTATIONS: A MULTIDIMENSIONAL APPROACH [1]

Previous studies demonstrated that automatic affective stimulus processing occurs only when affective stimulus information is attended to. In these studies, however, no manipulation checks were employed in which feature-specific attention allocation was measured directly. Our aim was to validate a method that allows for the measurement of the degree to which different stimulus dimensions are attended to. To this end, we encouraged participants to attend to different stimulus dimensions while they performed a similarity judgment task that allowed for the modeling of the attention weights that participants assign to different stimulus dimensions. In accordance with the framework of feature-specific attention allocation, participants who were encouraged to selectively attend to the affective stimulus dimension increased the salience of this dimension whereas participants that were encouraged to selectively attend to a non-affective stimulus dimension were found to increase the salience of this particular dimension.

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[1] Based on Everaert, T., Spruyt, A., & De Houwer, J. (2012). *Feature-specific attention allocation affects emotional stimulus representations: A multi-dimensional scaling approach.* Manuscript in preparation.

INTRODUCTION

It is generally assumed that humans are endowed with a mechanism that allows them to evaluate all incoming stimulus information in an unconditional, automatic fashion (e.g., Arnold, 1960; Bartlett, 1932; Lazarus, 1966; Wundt, 1907; Zajonc, 1980, 1984). A vast body of research has confirmed this intuitively appealing assumption: affective stimulus processing has been shown to draw upon fast-acting and efficient processes (Hermans, De Houwer, & Eelen, 2001; Hermans, Crombez, & Eelen, 2000; also see Klauer & Teige-Mocigemba, 2007), even in the absence of conscious identification of the instigating stimulus (Draine & Greenwald, 1998; Greenwald, Draine, & Abrams, 1996) or an explicit evaluative processing goal (e.g., Bargh, Chaiken, Raymond, & Hymes, 1996).

Recent studies conducted at our lab suggest, however, that automatic affective stimulus processing depends strongly on feature-specific attention allocation (FSAA; Spruyt, De Houwer, Everaert, & Hermans, 2012; Spruyt, Hermans, & De Houwer, 2009; Spruyt, Hermans, De Houwer, & Eelen, 2007). According to this framework, automatic affective processing of task-irrelevant stimuli is expected to occur if and to the extent that selective attention is directed towards affective stimulus features. In contrast, when attention is directed to other, non-affective semantic stimulus features, automatic affective processing of task-irrelevant stimuli is assumed to be reduced. Instead, enhanced processing of the stimulus features that participants do attend to is expected to occur.

Consider, for example, the findings of Spruyt et al. (2009). They manipulated FSAA while measuring automatic affective stimulus processing with a variant of the affective priming paradigm (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). In this paradigm, participants were asked to pronounce affectively polarized target words (e.g. Bargh, Chaiken, Raymond, & Hymes, 1996). Each target word was preceded by the short presentation of a task-irrelevant, affectively polarized prime word. Automatic affective processing of the prime stimulus is said to have taken place if task performance is influenced by the affective congruence between the prime and the target. Specifically, task performance is expected to be better when the prime and the target belong to the same affective category (e.g. “sunshine” and “kitten”) than when they do not (e.g. “murderer” and “kitten”). Spruyt et al. (2009) presented participants with a mixture of these affective priming trials with other affective priming trials that required either affective or non-affective semantic categorization of the target words. These trials were used to encourage participants to selectively attend to a given stimulus feature and will henceforth be called induction trials. During these induction trials, one group of participants (the affective group) was asked to categorize target stimuli as either positive or negative, whereas another group of participants (the non-affective group) was asked to categorize target stimuli as either referring to humans or to objects. The experimental context thus persuaded the affective group to selectively attend to affective stimulus information. The non-affective group, on the other hand, was persuaded to selectively attend to semantic stimulus information relevant for the discrimination between humans and objects. In line with the FSAA framework, effects of automatic affective stimulus processing (i.e., affective priming of naming responses) were found in the affective group but not in the non-affective group. In contrast, effects of automatic semantic stimulus processing were found in the non-affective group but not in the affective group (i.e., priming of the human and object categories).

Several studies further corroborated these results. For instance, Spruyt, De Houwer, Everaert, and Hermans (2012) demonstrated that even unconscious affective stimulus processing is dependent upon FSAA as well. Moreover, Everaert, Spruyt, and De Houwer (2011) further broadened the scope of the FSAA account showing that subtle cues, such as the proportion of affective stimuli in the experiment, can be sufficient to encourage participants to selectively attend to affective stimulus information.

In addition, Everaert, Spruyt, and De Houwer (2012) reasoned that FSAA should affect not only automatic affective stimulus processing per se, but also the processes that are assumed to take place once the evaluation of a certain stimulus has been established. It is well-known, for example, that affective stimuli capture attention, an effect dubbed “attentional bias” (for a review, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzerdoorn, 2007). Given that an attentional bias is contingent upon affective stimulus processing, Everaert et al. predicted automatic attentional biases for affective stimulus materials to depend on FSAA as well. In line with their expectations, they observed an attentional bias towards affective stimuli only when participants selectively attended to affective stimulus information. Moreover, when participants selectively attended to non-affective semantic information, they observed an attentional bias towards such non-affective semantic stimuli only.

Taken as a whole, these findings are certainly consistent with the hypothesis that variations in FSAA were the driving force behind the effects obtained. In none of these studies, however, was FSAA assessed directly. That is, the efficacy of the FSAA manipulations was simply inferred from the fact that indices of automatic affective stimulus processing (i.e., affective priming and attentional bias) were clearly affected by the experimental conditions. No independent measures of FSAA were administered and we therefore cannot be sure as to whether previously employed manipulations truly affected FSAA. As an independent measure of FSAA could provide us with a manipulation check, such a measure would further corroborate the abovementioned studies. To our knowledge, however, the number of methods that is readily available to measure the deployment of feature-specific attention is quite limited.

One method that can be used to achieve such an assessment of FSAA is the INDSCAL algorithm, a variant of multidimensional scaling (Carroll & Chang, 1970; Carroll & Wish, 1974). This algorithm allows for the derivation of a multidimensional space on the basis of similarity judgments of pairs of stimuli. The stimulus dimensions of the space correspond to the different stimulus features that can be selectively attended to (e.g. Figure 1a).

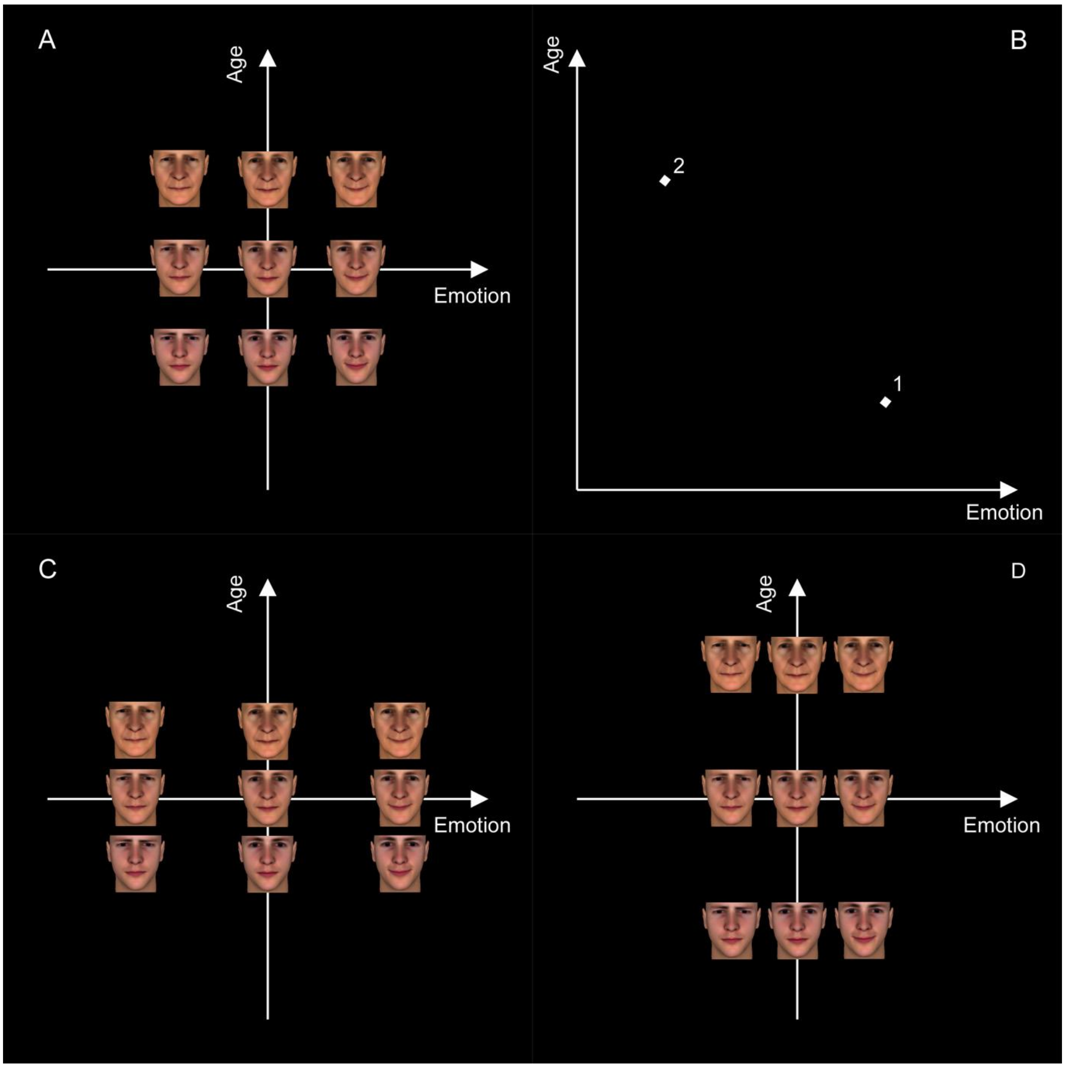

Figure 1. *Illustration of a multidimensional representation of 9 face images. A) A hypothetical representation that is common to all subjects. B) The weight space that indicates the weights for two hypothetical subjects. Subject 1 adds greater weight to the emotion dimension while Subject 2 adds greater weight to the age dimension. C) The private space of Subject 1 is the product of the common representation with the weights Subject 1 assigned to the dimensions. In this case, the emotion dimension stretches and the age dimension shrinks. D) The private space of Subject 2. Here, the age dimension is stretched while the emotion dimension shrunk.*

FSAA acts on this representation by weighting the dimensions of the space according to its direction and strength. Stimulus dimensions that are selectively attended to receive greater weight, get stretched out, and become more salient.

In contrast, stimulus dimensions that do not receive selective attention receive little weight, get shrunken, and become less salient. The INDSCAL algorithm yields parameters that reflect this differential weighting (e.g. Figure 1b-1d).

Fazio and Dunton (1997) provided an indication for the viability of this method in research on affective stimulus processing. They demonstrated that indices of racial bias, as measured with the affective priming paradigm, were correlated with the weights the participants assigned to the stimulus dimension related to race. As a racial bias is, in essence, an evaluation of a race, one can presume this correlation to hold for affective stimulus processing and feature-specific attention in general as well. Deutsch and Fazio (2008) further used INDSCAL to show that FSAA is a crucial mechanism involved in subtyping (Brewer, Dull, & Lui, 1981; Taylor, 1981). This phenomenon occurs when one is confronted with an exemplar of a certain stereotyped group that is, somehow, atypical for it (e.g. an introverted lead guitarist). Rather than changing the stereotype to fit the atypical exemplar, people generally create a new category, or subtype, for the exemplar, leaving the original stereotype unchanged. Deutsch and Fazio (2008) observed that when a group of atypical exemplars cluster together because of a common feature, people will add greater weight to the stimulus dimension related to this feature in order to separate the stereotyped group from the subtype. INDSCAL has also been applied in emotion research, with Halberstadt and Niedenthal (1997) showing that persons in an emotional state weight the emotional stimulus dimension more heavily than persons in a neutral state.

In the current study, we set out to assess the deployment of feature-specific attention with INDSCAL in a design similar to the one employed by Spruyt et al. (2009, 2012) and Everaert et al. (2012). We investigated this by presenting participants with a random mix of two kinds of trials, similarity judgment trials and induction trials. During the similarity judgment trials, participants were presented with pairs of faces that were taken from the stimulus set depicted in Figure 1. Participants were asked to judge the similarity of each face pair to obtain estimates of psychological distance, which were used for the reconstruction of the stimulus space and the idiosyncratic attention weights. The induction trials were used to encourage participants to selectively attend to a given stimulus dimension. During these trials, one group of participants (the emotion group) was asked to categorize faces according to the emotion they portray whereas another group (the age group) was asked to categorize faces according to the age they displayed. We hypothesized that the emotion group would add greater weight to the emotional stimulus dimension compared to the age dimension. Conversely, the age group was hypothesized to add greater weight to the age dimension than to the emotion dimension.

METHOD

Participants

Twenty-eight undergraduate students (M_{age} = 18.6 years, 25 males and 3 females) participated in the experiment for course credit. One participant was excluded from further analyses because of manifest unwillingness to comply with the instructions.

Materials

Different stimulus sets were generated for the similarity judgment task and the induction task. The different faces were created artificially using FaceGen Modeller 3.5 (http://www.facegen.com), a software tool that allows for controlled manipulations of different face images. We used it to systematically manipulate the age and emotional expression of computer-generated faces.

The similarity judgment set (see Figure 1a) consisted of nine images that were variations of one base face. These faces reflected combinations of two possible stimulus dimensions: emotion and age. With regard to the emotion dimensions, a face could either have a sad expression, a neutral expression, or a happy expression. With regard to the age dimension, a face could either look young (ca. 15 years old), middle-aged (ca. 40 years old), or old (ca. 60 years old). Combining the two stimulus dimensions thus resulted in 9 (3 × 3) possible faces, which were all used and depicted in Figure 1. Extensive piloting ensured both stimulus dimensions were approximately equally salient. Across different pilot studies, we systematically varied the salience of the stimulus dimensions until a sufficiently adequate multidimensional representation could be obtained.

To construct the induction set, we used nine different middle-aged faces with a neutral expression that were randomly generated by the Facegen program. The parameters used to create the similarity judgment set were used to create four variations of each of these nine faces: a sad version, a happy version, a young version, and an old version. These variations were used to comprise the induction set that thus consisted of a total of 36 face images (9 × 4).

Additionally, a practice set was created for the practice of the induction task. This set was constructed in the same way as the categorization set, but was created from eight randomly generated faces. The eventual practice set thus consisted of 32 face images (8 × 4).

All face images had a width of 135 px and a height of 130 px. In addition, we created an image to use as a backward mask and a forward mask for the previously described face images. This image represented random noise and measured 250 × 250 px.

All images were presented on the black background of a 19 inch screen with a resolution of 1024 × 768 px and a refresh rate of 100 Hz. The experiment was controlled with a computer with an Intel D930 (3.2 GHz) processor through an Affect 4.0 program (Spruyt, Clarysse, Vansteenwegen, Baeyens, & Hermans, 2010). The computer's parallel port was connected to a voice key that recorded the responses during the induction trials. Responses during the similarity judgment trials were recorded with a standard AZERTY keyboard.

Procedure

We tested all participants in a dimly lit room and randomly assigned them to either the Emotion group (*n* = 13) or the Age group (*n* = 14). They were seated in front of the screen that displayed the instructions, showing them how to perform the different trials. The experimenter clarified the instructions when necessary.

An induction trial started with the presentation of a fixation cross in the center of the screen. After an interval of 500 ms, the fixation cross was erased and replaced by the masking image for 200 ms. This mask was immediately followed by the 500-ms presentation of a face image, after which the mask was shown again for another 200 ms. Participants in the Emotion group were asked to vocally categorize the shortly presented face images as either “happy” or “sad”, whereas participants in the Age group were asked to vocally categorize them as being either “young” or “old”. The experimenter manually coded the response afterwards and initiated an inter-trial interval that varied randomly between 500 ms and 1500 ms.

The similarity judgment trials also started with the 500-ms presentation of a fixation cross in the center of the screen. But afterwards, two mask images were presented directly next to each other in the middle of the screen for another 200 ms. The masks were replaced by two different face images that were presented for 500 ms and were ca. 115 pixels apart. The faces were then replaced by the masks which were presented for the same duration and in the same location as the first masks. Participants were asked to rate the similarity of the two faces on a four-point scale using the keyboard. The similarity scale ranged from very similar (‘x’) and slightly similar (‘v’), to slightly different (‘n’) and very different (‘;’). As to avoid any confusion with the pressing of the keys, participants were requested to keep their fingers on these keys during the course of the experiment. They were asked to base their judgment on all possible differences they could distinguish, and to not just focus on one feature only.

For all trial types, participants were asked to respond within 2 seconds, or the trial would end with a 300-ms visual message that informed them that they were too slow (“!!!TE TRAAG!!!”).

Participants first performed a block of 32 practice trials consisting of induction trials only. Participants in the Emotion group performed this task on the 8 sad and 8 happy practice face images. Participants in the Age group performed this task on the 8 young and 8 old practice face images. Each of these images was presented twice throughout the practice phase.

Afterwards, an experimental block of 144 trials was performed that contained 72 induction trials and 72 similarity judgment trials that were randomly intermixed. The Emotion group performed the induction task on the 9 happy and 9 sad faces whereas the Age group performed the induction task on the 9 young and 9 old faces. Within each group, each image was presented 4 times, leading to a total of 72 induction trials. For the 72 similarity judgment trials, every possible pairing (36 pairs) of the 9 faces in the similarity judgment stimulus set was presented twice each. The position of each face in the pair presentation was chosen at random.

RESULTS

The stimulus space was created on the basis of the similarity judgment data. For each participant, a dissimilarity matrix was created that represented the dissimilarities of the 36 possible face pairs. In the next step, these data were entered into SPSS 15.0 (SPSS, Inc., 1990) and were subjected to INDSCAL, which is part of the ALSCAL procedure in the program.

The data of two participants were removed as their dissimilarity matrices conflicted heavily with those of the other participants, suggesting they might have reversed the scale. Consequently, their S-stress value, a measure of error in ALSCAL, exceeded our outlier criterion of 2.5 standard deviations above the mean. We performed the INDSCAL algorithm (Carroll & Chang, 1970; Carroll &

Wish, 1974) on the data of the remaining 25 participants. The algorithm iteratively improved a random representation until a convergence criterion was reached that indicated the decrease in S-stress was negligible (below .0001). As the stimuli we used in the study varied only on two possible stimulus dimensions, we decided to constrain the solution to this number of dimensions (see Figure 2, for the eventual representation.

The INDSCAL procedure reached the preset convergence criterion after 10 iterations. The final representation had an S-stress of .27 and explained, on average, 73.4 % of a participant's variance. Figure 2a shows a representation of the common stimulus space, the multidimensional representation common for all subjects. The dimensions of this common space clearly correspond to the emotion dimension and the age dimension. However, the emotionally neutral faces seem to cluster together with the sad faces, which might reflect an anchoring effect (Scherer & Lambert, 2009).

The distribution of the weights (Figure 2b) shows that the Emotion group and the Age group differentially weight the two stimulus dimensions. The means displayed in Table 1 clearly confirm that participants in the Emotion group assign greater weight to the emotion dimension than to the age dimension, while the participants in the Age group assign greater weight to the age dimension than to the emotion dimension. It is not common practice, however, to perform statistical tests on these individual dimension weights (Jones, 1983; MacCallum, 1977). We performed the analysis on the "flattened subject weights", which reflect the weight ratios (Rodgers, 1985; Schiffman, Reynolds, & Young, 1981; Young, 1982). A positive flattened weight indicates dominance of the emotion dimension over the age dimension, while a negative flattened weight indicates dominance of the age dimension over the emotion dimension.

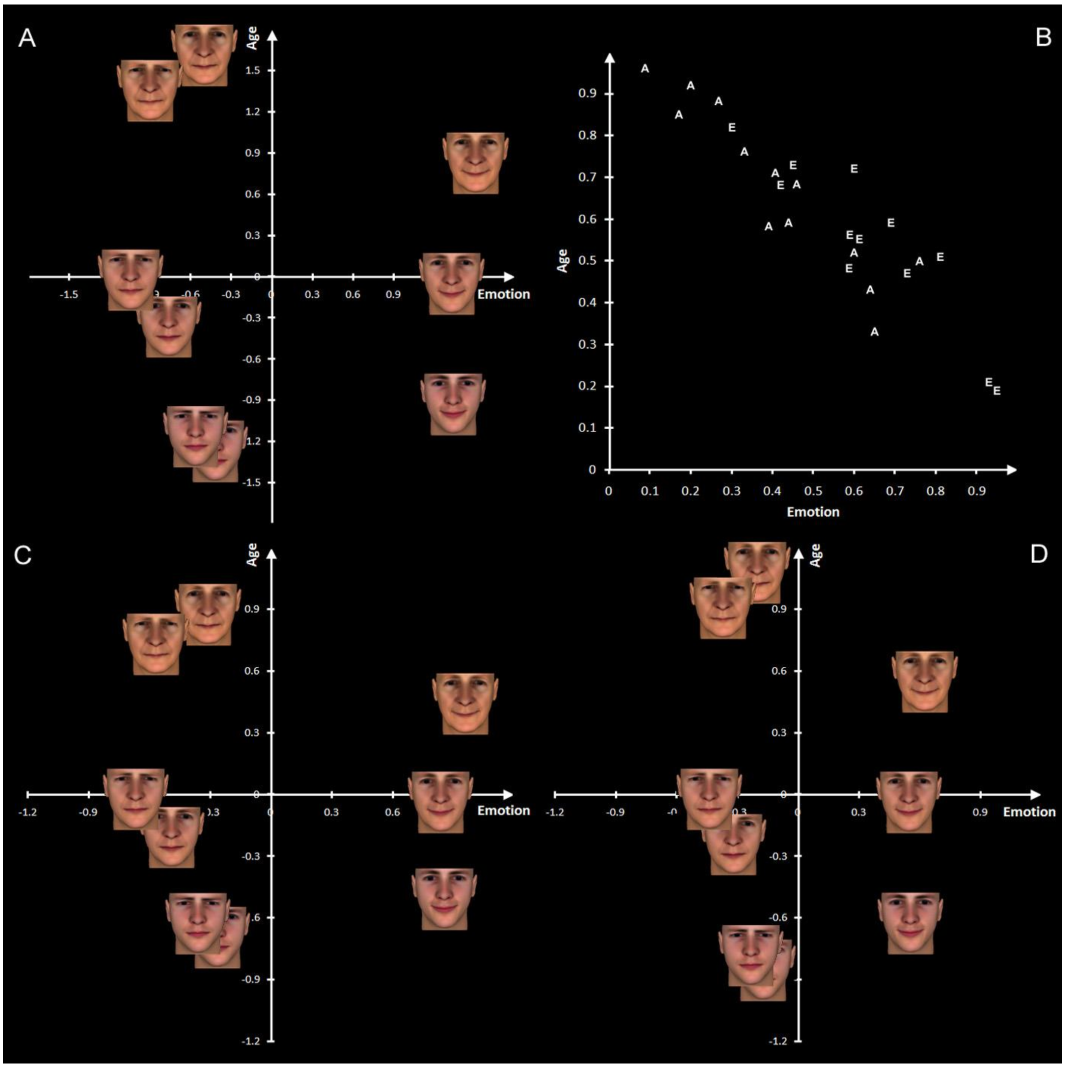

Figure 2. *The multidimensional representations extracted from the participants' similarity judgments. A) The common space representing the 9 face images. B) The weight space showing the distributions of the participants' weights. Points marked with an 'E' represent participants in the Emotion group. Points marked with an 'A' represent participants in the Age group. C) The private space associated with the mean weights of the Emotion group. D) The private space associated with the mean weights of the Age group.*

In line with our hypothesis, the flattened subject weights of the Emotion group and the Age group were significantly different, $t(23) = 2.27$, $p < .05$, $d = 0.94$. This difference suggests that there are group differences in the allocation of selective attention. In the Emotion group, the emotion dimension was attended to more than the age dimension. In the Age group, the age dimension was attended to more than the emotion dimension.

Table 1.

Mean dimension weights, flattened weights and their respective standard deviations, as a function of group. Positive flattened subject weights indicate a greater weighting of the emotion dimension than the age dimension. Negative flattened subject weights indicate a greater weighting of the age dimension than the emotion dimension.

	Stimulus dimension					
	Emotion		Age		Flattened weight	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*
Emotion	.68	.20	.54	.19	.44	.90
Age	.42	.21	.67	.20	-.41	.98

DISCUSSION

In contrast with the popular belief that humans are capable of evaluating all incoming stimuli, recent studies have shown that automatic affective stimulus processing is not as unconditional as previously assumed (Everaert et al., 2012; Spruyt et al. 2007, 2009, 2012). These studies suggested that automatic affective stimulus processing will occur only when selective attention is directed to affective stimulus information. When selective attention is directed to any other source of stimulus information, automatic affective stimulus processing does not take place, but rather enhanced processing of the non-affective stimulus information that is selectively attended to. This framework can be conceptualized by representing perceived stimuli in a psychological, multidimensional space with dimensions corresponding to various stimulus features. FSAA acts on this representation by stretching those dimensions that are selectively attended to and shrinking those dimensions that do not receive selective attention.

In the studies corroborating this account, however, FSAA was never measured independently and no manipulation checks were administered. We therefore set out to develop a method that would allow for the measurement of FSAA through its effects on the abovementioned multidimensional space. Such a method would allow us to further validate earlier studies, showing that manipulations employed in these studies truly affected FSAA. Furthermore, the multidimensional scaling method could be used in future studies as a manipulation check.

In one study, we presented participants with two, randomly intermixed tasks. First, a categorization task was used to encourage participants to attend to either the affective stimulus dimension or a non-affective stimulus dimension. Second, a similarity judgment task was used to obtain the psychological similarities of pairs of stimuli. These similarity judgments could be used to reconstruct a multidimensional representation of the participants' psychological stimulus space. In accordance with our predictions, participants attached a greater attentional weight to those stimulus dimensions that were hypothesized to be attended to. Participants that were encouraged to selectively attend to emotional features added greater weight to the emotion dimension than to the age dimension. In contrast, participants that were encouraged to selectively attend to age-related features added greater weight to the age dimension than to the emotion dimension.

Measures of FSAA thus proved to be sensitive to a manipulation similar to the one employed by Spruyt et al. (2007, 2009, 2012) and Everaert et al. (2012). This finding further corroborates these studies, indicating that FSAA, in all likelihood, was the crucial factor at play in these studies. This measure can be used as a manipulation check in future studies as well. Furthermore, measures of FSAA might prove fruitful in the future to show a more linear dependency of automatic affective stimulus processing on FSAA.

We hope to test this in the future with a design in which we mix similarity judgment trials with affective priming trials wherein the naming task is used.

Similar to Fazio and Dunton's (1997) studies, we hypothesize the weights participants assigned to the affective stimulus dimension are correlated with participants' affective priming indices. Furthermore, we expect both indices to be sensitive to a manipulation of FSAA. We can manipulate FSAA much the same way as Everaert et al. (2011) did, by embedding the affective priming trials in a context of either other affective priming trials (affective group) or neutral priming trials (non-affective group). The context of affective stimuli in the affective group will encourage the group to selectively attend to the affective stimulus dimensions whereas the context of neutral stimuli in the non-affective group will not. Consequently, the INDSCAL algorithm would yield larger attention weights for the affective stimulus dimension in the affective group compared to the non-affective group. In turn, these attention weights should correlate significantly with the obtained affective priming indices across conditions.

The use of MDS could prove fruitful in more applied contexts of research on affective stimulus processing as well. More specifically, measures of affective stimulus processing have been used to measure personal preferences and attitudes (De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009; Fazio & Olson, 2003). The dependency of automatic affective stimulus processing on FSAA can potentially hamper the predictive validity of such measures. If the attitude and the to-be-predicted behavior are assessed under different circumstances of FSAA, the predictive validity of the attitude measure could be severely decreased. Perhaps taking attention weights into account could increase the validity of measures of attitudes.

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GENERAL DISCUSSION

As early as the beginning of the previous century, several authors advocated the hypothesis that humans are capable of evaluating all incoming stimulus information in an unconditional, automatic fashion (e.g., Arnold, 1960; Bartlett, 1932; Lazarus, 1966; Wundt, 1907; Zajonc, 1980, 1984). Experimental support for this idea has grown steadily over the last decades, both in the behavioral sciences and the neurosciences. Recent research, however, suggests that automatic affective stimulus processing is not unconditional but depends on feature-specific attention allocation (FSAA; Spruyt, De Houwer, Everaert, & Hermans, 2012; Spruyt, De Houwer, & Hermans, 2009; Spruyt, De Houwer, Hermans, & Eelen, 2007). According to this framework, automatic affective stimulus processing will occur only to the extent that affective stimulus information is selectively attended to. Furthermore, automatic processing of non-affective semantic stimulus features is also assumed to depend on the extent to which non-affective semantic stimulus information is attended to.

Spruyt et al. (2007, 2009, 2012) provided support for this framework using affective priming of naming responses as a marker for automatic affective stimulus processing. In the affective priming paradigm, naming responses towards affectively polarized target stimuli are generally faster and more accurate when the target stimuli are preceded by affectively congruent prime stimuli than when the targets are preceded by affectively incongruent prime stimuli (e.g. Bargh, Chaiken, Raymond, & Hymes, 1996). This effect can occur only if the affective value of the prime stimulus has been processed and can therefore be exploited as a marker for affective stimulus processing. In several studies, these naming trials were presented together with categorization trials aimed at encouraging participants to selectively attend either to affective stimulus information or non-affective semantic stimulus information. During these categorization trials, one group of participants (the affective group) was asked to categorize target stimuli as either positive or negative, whereas another group of participants (the non-affective group) was asked to categorize target stimuli as either humans or objects. In accordance with the framework of FSAA, reliable affective priming of naming responses was observed in the affective group only. Conversely, categorical semantic priming effects were found in the non-affective group only. In this group, naming responses were faster when the prime and target stimulus belonged to the same semantic category (e.g. both prime and target referring to a human) than when they did not (e.g. a prime referring to an object and a target referring to a human). Such effects of FSAA were consistently found in several studies and persisted even when primes were presented subliminally (Spruyt et al., 2007, 2009, 2012).

Automatic affective stimulus processing thus depends on the extent to which affective stimulus information is selectively attended to. The framework of FSAA implies several additional predictions that were tested over the course of this research project.

OVERVIEW

In **Chapter 1**, we set out to demonstrate that even subtle aspects of the experimental procedure can encourage one to selectively attend to affective stimulus information. After all, effects of automatic affective stimulus processing have been found in numerous studies without manipulations of FSAA. Nevertheless, according to the framework of FSAA such effects must have come about because participants were somehow encouraged to attend to affective stimulus information. One procedural aspect that is present in many studies is the high proportion of affective stimuli. The mere presentation of many affectively polarized stimuli in a study might evoke selective attention towards affective stimulus information. We investigated this possibility in one experiment in which we presented participants with affective priming trials in which participants were asked to name the target stimuli. In one group of participants (the affective group), these trials were presented together with a majority of other affective priming trials, thus guaranteeing a high proportion of affective stimuli. In another group of participants (the non-affective group), the affective priming trials were presented together with a majority of priming trials that contained affectively neutral stimuli, thus guaranteeing a low proportion of affective stimuli. Affective priming of naming responses was observed in the affective group only. A high proportion of affectively polarized stimuli thus seems sufficient in encouraging participants to attend to affective stimulus information. This mechanism might explain why effects of affective stimulus processing were easily found in other studies without explicit manipulations of FSAA.

In **Chapter 2**, we tested the prediction that, if FSAA impacts automatic affective stimulus processing, it should also affect consequences of automatic affective stimulus processing. One consequence of automatic affective stimulus processing is the power of affective stimuli to grab attention. Once an affective stimulus is processed, it can attract attention, an effect commonly referred to as “attentional bias” (for a review, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Yiend, 2010). In two experiments, we therefore tested whether a manipulation of FSAA affects attentional bias, as measured with the emotional Stroop task in Experiment 1 (Pratto & John, 1991), and the dot probe task in Experiment 2 (MacLeod, Mathews, & Tata, 1986). The measures of attentional bias were presented on half of the trials in each experiment. On the other half of the trials, participants were asked to perform a categorization task that was aimed at encouraging them to selectively attend either to affective stimulus information or to non-affective stimulus information. More specifically, one group of participants (the affective group) was asked to categorize target stimuli as either negative or not negative. The other group of participants (the non-affective group) was asked to categorize target stimuli as denoting either humans or not humans. As a result, the former group was encouraged to selectively attend to affective stimulus information while the latter group was encouraged to selectively attend to non-affective semantic stimulus information useful for distinguishing humans from non-humans. In line with the FSAA framework of Spruyt et al. (2009), FSAA modulated attentional bias in both experiments. Attentional bias towards negative stimuli was observed in the affective group only. Conversely, if present, an attentional bias towards stimuli denoting humans was observed in the non-affective groups only.

In **Chapter 3**, we used another marker of attentional bias to further corroborate the hypothesis put forward in Chapter 2. An unpredictable stimulus in a sequence of predictable stimuli generally attracts attention, which can be measured using EEG. Typically, unpredictable stimuli evoke a positive deflection with a frontocentral maximum roughly 250 ms after stimulus presentation. This P3a-component (Polich, 2007), has shown to be sensitive especially to emotional changes in stimuli (Campanella et al., 2002). In an EEG study, we presented participants with a series of neutral, middle-aged faces interspersed with infrequent faces that deviated from the other faces on the basis of their emotional expression (happy or sad) or their age (young or old). Participants were, again, divided in two groups. The affective group was asked to make a response to either the happy or the sad faces, depending on the experimental block. The non-affective group was asked to make a response to either the young or the old faces, depending on the experimental block. As a result, the affective group was encouraged to selectively attend to affective stimulus information and the non-affective group was encouraged to selectively attend to non-affective age-related stimulus information. Again, FSAA was shown to modulate the size of the P3a evoked by rare stimuli. Faces that deviated from the neutral, middle-aged faces in terms of their valence evoked a significant P3a in the affective group only. Faces that were infrequent with respect to their age evoked a tendency towards a P3a in the non-affective group only. In sum, Chapter 2 as well as Chapter 3 provided convincing evidence for the hypothesis that FSAA impacts not only automatic affective stimulus processing per se, but also the consequences of this automatic affective stimulus processing, such as attentional bias.

In **Chapter 4**, we addressed a methodological concern related to the previous studies. In none of the earlier studies an independent measure of FSAA was administered and no manipulation check was thus incorporated in the experimental designs. The effectiveness of the manipulation of FSAA was simply deduced from its effects on measures of automatic affective stimulus processing. We therefore set out to validate a method that allows one to measure the extent to which different stimulus features are selectively attended to. Such a method could be used in future studies as a manipulation check and could be used to assess whether automatic affective stimulus processing is linearly dependent on FSAA. In one experiment we used the INDSCAL algorithm (Carroll & Chang, 1970) to achieve a measurement of FSAA.This algorithm converts subjects' similarity judgments between different objects into a multidimensional, spatial representation of these objects. The dimensions of this representation correspond to the different features defining the objects. Importantly, the algorithm yields a set of weights that reflect the idiosyncratic weighting of the representation according to FSAA. We presented participants with similarity judgment trials to allow for a reconstruction of this multidimensional representation. These trials were intermixed with categorization trials to encourage participants to selectively attend to either affective stimulus information (the affective group) or non-affective stimulus information (the non-affective group). In line with our predictions, bigger attentional weights were assigned to stimulus dimensions that were selectively attended to than stimulus dimensions that were not selectively attended to. In a future study, we will correlate these attentional weights with affective priming indices to investigate whether the extent of automatic affective stimulus processing is linearly dependent on the extent of FSAA.

In sum, the studies described in the current project extend the framework of FSAA. First, FSAA can be induced by the mere presentation of affective stimuli. Second, the effects of FSAA on affective stimulus processing also extend to consequences of affective stimulus processing. In particular, attentional bias to affective stimuli was shown to depend FSAA. Third, effects of FSAA can be measured using multidimensional scaling algorithms. These measurement procedures can be used in future research as a manipulation check.

DISCUSSION

Automaticity

First of all, it is important to stress that the current findings do not warrant the conclusion that affective stimulus processing occurs in a non-automatic fashion. Automaticity is a complex construct that cannot be considered an all-or-none phenomenon (Moors & De Houwer, 2006). It is best conceived of as an umbrella term grouping together several defining, but independent features. This conceptualization stems from the finding that there is no one-to-one relation between any pair of automaticity features. The presence of one automaticity feature does not imply the presence of other features, nor does the absence of one feature imply the absence of others. Such weak relations between features hamper the internal consistency of the automaticity concept and warrant a more decompositional approach to automaticity. According to this approach, it is best to investigate each feature separately. Taking these considerations into account, it must be clear that the mere observation that FSAA impacts automatic affective stimulus processing, does not warrant the conclusion that affective stimulus processing proceeds in a non-automatic fashion. After all, in spite of this precondition, affective stimulus processing can still occur in a fast and efficient fashion, independently of conscious awareness (Spruyt et al., 2012). The present findings merely contest the alleged unconditionality of affective stimulus processing and suggest FSAA is a necessary precondition for its occurrence.

Implications

The multidimensional approach

Perhaps the most important implication of the framework of FSAA is that feature-specific attention impacts non-affective and affective stimulus dimensions in a similar way. As a result, the framework also has implications for research on the processing of non-affective stimulus dimensions and the relations between these stimulus dimensions.

I propose that this general framework can be conceptualized within a multidimensional approach which entails that different stimuli can be represented in a multidimensional psychological space. The stimulus dimensions can refer to all possible features that define the stimuli. The processing of various such dimensions has been the topic of many ongoing research efforts. Especially in social psychology, many stimulus dimensions that are implicated in attitudes and stereotypes have been shown to be processed in an automatic and unconditional fashion. Aside from the affective stimulus dimension, which has been central to the current project, such stimulus dimensions include race (e.g. Plous, 2002; Schneider, 2004), gender (e.g. Swann, Langlois, & Gilbert, 1999), and age (e.g. Nelson, 2005).

These stimulus dimensions do not need to be fully orthogonal, but can relate to one another. Stimulus dimensions can thus be oblique, or correlated, which can be used to represent several popular psychological constructs such as attitudes and stereotypes (e.g. Greenwald, Banaji, Rudman, Farnham, Nosek, & Mellott, 2002).

An attitude, for instance, is essentially an association between a stimulus, or class of stimuli, and an affective attribute (Greenwald et al., 2002). Within the multidimensional approach, attitude-relevant stimuli thus load highly on the affective stimulus dimension. Furthermore, as classes of attitude-relevant stimuli can be conceptualized as attitude-relevant stimulus dimensions (e.g. race), their corresponding attitudes can be represented by a correlation between these attitude-relevant stimulus dimensions and the affective stimulus dimension. In Figure 1, for instance, racial attitudes can be represented in a multidimensional space with two stimulus dimensions: a race dimension and an affective stimulus dimension. When no racial bias is present, the two stimulus dimensions are completely orthogonal, showing no correlation between race and valence (Figure 1a). When racial bias is present, however, the two stimulus dimensions are assumed to be oblique, reflecting a correlation between race and valence (Figure 1b). As a result, exemplars with high values on the race dimension will have more extreme values on the affective stimulus dimension as well. Specific forms of anxiety and phobias may also be conceptualized as reflecting extreme attitudes in this sense. Phobia-relevant stimulus dimensions are assumed to correlate heavily with the affective stimulus dimension.

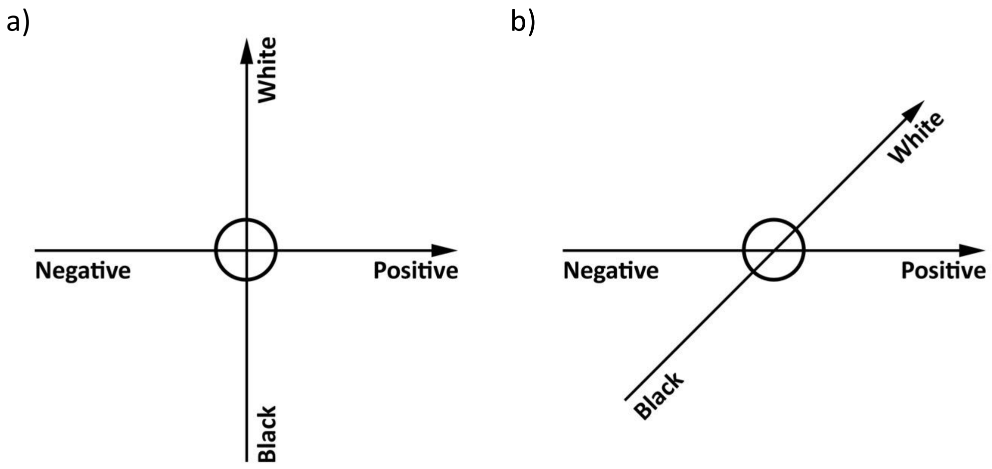

Figure 2. *Multidimensional conceptualization of attitudes towards different races. a) No racial bias is present: the race dimension and the affective stimulus dimension are orthogonal. b) A racial bias is represented by a sharper angle between the race dimension and the affective stimulus dimension.*

A stereotype, which can be defined as an association between a class of stimuli and non-affective attributes (Greenwald et al., 2002), can readily be represented by oblique stimulus dimensions as well. In this case, stereotypes reflect a correlation between non-affective stimulus dimensions. Consider, for instance, the stereotype that “white men can’t jump”, which is very popular in basketball culture (e.g. Shelton, 1992). This stereotype can be conceptualized as a correlation between a race dimension and a stimulus dimension depicting a person’s ability to jump (Figure 2).

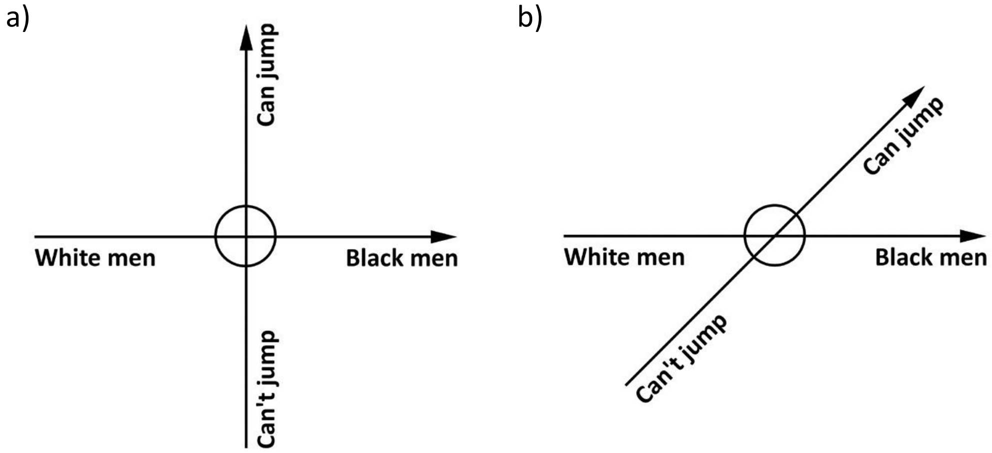

Figure 2. *Multidimensional conceptualization of the stereotype that "white men can't jump". The horizontal stimulus dimension reflects race while the other stimulus dimension reflects one's ability to jump. The stereotype is present only in panel b, as shown by the oblique stimulus dimensions.*

Aside from attitudes, phobias and stereotypes, many "automatic associations" have surfaced in psychological research that can be represented by oblique stimulus dimensions in the multidimensional approach as well. Such automatic associations have been suggested to be involved in many social issues such as sexual harassment and alcohol abuse. Bargh, Raymond, Pryer, and Strack (1995), for instance, used a priming paradigm to show that the concepts 'power' and 'sex' are associated with each other in men who are more likely to sexually harass (also see, Mussweiler & Forster, 2000). Subra, Muller, Begue, Buschman, and Delmas (2010) reported similar associations between alcohol and aggression, also using a priming paradigm. These automatic links can easily be conceptualized by allowing correlations between the involved stimulus dimensions such as a power dimensions and a sex dimension, or a dimension related to alcohol content and a dimension related to amount of aggression.

FSAA is thought to operate on the multidimensional space by stretching those stimulus dimensions that are selectively attended to and shrinking the stimulus dimensions that are not selectively attended to (e.g. Medin & Schaffer, 1978; Nosofsky, 1986). As a result, stimulus differences along stretched dimensions become more apparent and easier to process while stimulus differences along shrunken dimensions become less apparent and harder to process. Importantly, this mechanism influences affective stimulus dimensions as well as non-affective stimulus dimensions. The framework thus implies that not only automatic affective stimulus processing is dependent on FSAA, but also the processing of other stimulus features such as the previously mentioned age, race, and gender. The activation of attitudes, stereotypes, and automatic associations (e.g. alcohol and aggression; Subra et al., 2010) thus depends on FSAA as well. Consequently, research on the effects of feature-specific attention allocation in these aforementioned research topics might prove fruitful and add greatly to the understanding of such phenomena and their effects on behavior.

Flexibility of feature-specific attention allocation

FSAA is driven by the goals held by the person. The flexibility with which feature-specific attention is switched across stimulus dimensions and with which it is deployed to stimulus dimensions is further dependent on the perseverance of such goals. There are several possible instances that bias this flexibility and could lead to an almost chronic deployment of feature-specific attention to certain stimulus dimensions.

First, it is possible that, given the adaptive importance, selective attention is assigned to the affective stimulus dimension by default. Such default allocation might partly explain why effects of automatic affective stimulus processing are easily found without explicit manipulations of FSAA. Apart from the subtle cues in the experimental procedure laid out in Chapter 1, participants might attend to the affective stimulus dimension because it is adaptive to do so. Nevertheless, this default mode of FSAA might be overwritten flexibly in favor of the current task demands and goals.

Second, some goals might be of such importance to a particular person that attention is assigned chronically to the stimulus dimensions that are somehow related to the particular goal. For instance, populations poor in emotion regulation and high in anxiety seem to be biased to selectively attend to the affective stimulus dimension. For instance, poor emotion regulators have been shown to be less flexible in switching between a task that requires one to selectively attend to the affective stimulus dimension and a task that requires one to selectively attend to a non-affective stimulus dimension (Genet & Siemer, 2011; Johnson, 2009).

This bias could persevere even more in populations suffering from anxiety disorders, as evidenced by the bulk of findings showing attentional bias in these populations (Bar-Haim et al., 2007). Aside from attentional bias towards generally negative stimuli, many instances have been found of attentional bias to specific stimuli relating to the concerns of a population with a given psychopathology (Williams, Matthews, & MacLeod, 1996). Mogg, Mathews, and Weinman (1989) for instance, observed that socially anxious individuals showed greater emotional Stroop effects for words that were related to social threat than to physical threat. Anxious individuals with physical worries on the other hand, showed greater emotional Stroop effects for words related to physical threat than to social threat. Watts, McKenna, Sharrock, and Trezise (1986) observed tremendous emotional Stroop effects for spider related words in Spider phobics, and Foa, Feske, Murdock, Kozak, and McCarthy (1991) detected similar effects for words related to rape in a sample of rape victims. Furthermore, multidimensional scaling studies have shown that spider-fearful persons add greater weight to the affective stimulus dimension than non-fearful persons (Cavanagh & Davey, 2001). Persons showing bulimic symptoms on the other hand, tend to weight the stimulus dimension related to body size more than persons that don’t show such symptoms (Viken, Treat, Nosofsky, McFall, & Palmeri, 2002).

Much like phobic and high-anxious populations chronically attend to stimulus dimensions relevant to the specific pathology, some attitudes might be of such personal relevance that the attitude-relevant stimulus dimensions are rigidly attended to as well. In accordance with the framework of FSAA, effects of automatic attitude activation should therefore be found more readily for those objects that are of importance to the specific subject. This idea fits nicely with earlier theorizing by Fazio (1990) who coined the term “attitude accessibility” to refer to differences in which objects activate their corresponding attitudes. High accessible attitudes are easily activated upon perception of the instigating object while low accessible attitudes are hardly activated at all upon perception of the attitude-relevant object. Moreover, attitudes that are highly accessible are usually personally relevant as well (Bizer & Krosnick, 2001; Krosnick, 1989). The framework of FSAA adds to this idea by proposing that these highly accessible attitudes are activated automatically and unconditionally because the attitude-relevant stimulus dimensions are chronically attended to.

Nevertheless, Fazio’s (1990) model received some criticisms from authors showing that even low accessible attitudes seem to be activated unconditionally (Bargh, Chaiken, Govender, & Pratto, 1992; Bargh et al., 1996). This inconsistency might be accounted for by the framework of FSAA, which also proposes that aspects of the experimental procedure can influence FSAA (e.g. Chapter 1; Spruyt, Everaert, De Houwer, Moors, & Hermans, 2008). For instance, subtle cues in the experimental procedure could have encouraged participants to selectively attend to the affective stimulus dimension. This encouragement might have led to the automatic activation of any attitude, regardless of its accessibility under natural circumstances (e.g. Chapter 1).

Measures of attitudes

Since attitudes are, in essence, evaluations of stimuli (e.g. Allport, 1935), there has been a long line of research using measures of automatic affective stimulus processing to measure automatic attitude activation (De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009; Fazio & Olson, 2003). Such “implicit” measures are thought to hold a crucial benefit over explicit attitude measures because they are assumed to be affected less by response bias, inaccessibility in consciousness, and social desirability (but see, Czellar, 2006; De Houwer, Beckers, & Moors, 2007). However, the framework of FSAA has far-reaching implications for research on automatic attitude activation. The framework predicts that automatic affective stimulus processing occurs only to the extent that affective stimulus information is selectively attended to. Consequently, automatic attitude activation does not occur unconditionally but surfaces only when attention is directed to affective stimulus features. As mentioned in the previous paragraph, while FSAA might be assigned chronically to some important attitude-relevant stimulus dimensions, it can be changed flexibly in function of the current goals.

This malleability of FSAA can severely hamper the reliability and validity of implicit measures of attitudes. First, fluctuations in patterns of FSAA affect the expression of attitudes over time and situations, weakening the reliability of the measures. Second, their construct validity is also affected because attitudes are only measured under some circumstances. Moreover, when attitudes do surface in implicit measures, they reflect the joint effect of the attitude and FSAA. Third, the predictive validity of implicit measures suffers greatly as well. If the activation of an attitude is dependent on FSAA, so is the behavior instigated by those attitudes. Consequently, an implicit measure will not predict behavior when the attitude and the to-be-predicted behavior are not assessed under similar conditions of feature-specific attention. For instance, if an attitude is assessed when selective attention is directed towards affective stimulus information, the measure will not predict behavior occurring in situations in which affective stimulus information is not selectively attended to. Moreover, when selective attention is not directed to affective stimulus information during measurement, the measure will not predict any behavior as attitudes where not activated during measurement and were therefore not assessed.

Furthermore, the process of measurement can influence FSAA as well. In many implicit measures, tasks are used that encourage participants to selectively attend to affective stimulus information. For instance, the affective priming paradigm (Fazio, Sanbonmatsu, Powell, & Kardes, 1986), the implicit association test (Greenwald, McGhee, & Schwartz, 1998), and the affect misattribution procedure (Payne, Cheng, Govorun, & Stewart, 2005) all employ the affective categorization task. Such a task requires participants to selectively attend to the affective stimulus dimension to ensure good performance (e.g. Spruyt et al., 2009). Participants strategically assign attention so as to maximize the differences between positive and negative stimuli while minimizing the differences within these respective stimulus categories (see Smith & Zaraté, 1992, for an example on social categorization). Under these circumstances, such an extreme enhancement by attention can boost the affectivity of even the most insignificantly affective stimulus. Consequently, the procedure may drastically reduce inter-individual differences in spontaneous automatic attitude activation, rendering the measurement ineffective. Moreover, aspects of the experimental procedure other than the specific task used can implicitly encourage one to selectively attend to affective stimulus information as well. In Chapter 1, for instance, we demonstrated that even the mere presentation of affectively polarized stimuli can engender such effects.

Such obstacles might be overcome by using implicit measures that do not affect FSAA. These measures would be sensitive only to those attitudes that are personally relevant and consequently subject to chronic attention. Measures that do not include an affective categorization task might therefore be more suitable to measure personally relevant attitudes. Spruyt, Hermans, De Houwer, Vandekerckhoven, and Eelen (2007; also see Vandromme, Hermans, & Spruyt, 2011) showed that one such a task, the picture-picture naming task, has good predictive power. In this variant of the affective priming paradigm, prime and target stimuli are pictures and participants are asked to name the target pictures. Spruyt, Hermans et al. (2007) used this task to predict participants' choice between either fruit or a candy bar. The obtained affective priming indices were found to predict this consumer choice behavior better than other measures that employed an affective categorization task. While the presentation of affective stimuli in this task might encourage one to selectively attend to the affective stimulus dimension, it does so to a lesser extent than the explicit use of an affective categorization task. Moreover, measuring the attitude instigated by an object is virtually impossible without presenting the object in question.

Multidimensional scaling algorithms might prove useful in the context of attitude measurement as well. The IDIOSCAL algorithm, for instance, is an extension of the INDSCAL algorithm that allows for the extraction of stimulus dimensions, the idiosyncratic weighting of the dimensions, and importantly, the angles between the stimulus dimensions (Carroll & Chang, 1972). Furthermore, the input of the algorithm can consist of simple similarity judgments and no affective categorization is necessary. As mentioned above, an attitude can be reflected in the multidimensional approach by a correlation between an attitude-relevant stimulus dimension (e.g. race, gender, …) and the affective stimulus dimension. IDIOSCAL can recover such a correlation from similarity judgment data and can thus provide an alternative attitude measure. In addition, stereotypes can be measured in a similar fashion by recovering the correlation between the stimulus dimension related to the social group (e.g. race, gender,…) and a stimulus dimension related to the stereotypical attribute (e.g. ability to jump, ability to drive). Patterns of FSAA can be taken into account with the dimension weights yielded by the algorithm. As the stimulus dimensions related to stronger attitudes are more chronically attended to, one could index attitude strength by the consistency with which attitude-relevant stimulus dimensions are attended to under different conditions.

Psychopathology

As mentioned above, FSAA might be implicated in psychopathology as well. Selective attention might be assigned chronically to those stimulus dimensions that are of great relevance to a specific psychopathological population. This chronic attention assignment can lead to an attentional bias, as evidenced in Chapter 2. Such attentional biases have been presupposed to play a crucial role in anxiety (e.g. Mogg & Bradley, 1998). Many attempts have therefore been made to alter anxiety by altering attentional bias through so-called "attentional retraining" (Macleod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). In attentional retraining studies, participants are trained to attend either towards or away from threatening stimuli in a modified version of the dot probe task (MacLeod et al., 1986). In a common dot probe task, participants are asked to respond to the location of visually presented dot probes on the screen. Each probe is preceded by the short, simultaneous presentation of a neutral and a threatening stimulus in two different locations of the screen. An attentional bias is thought to have occurred when responses are faster when the probe is presented on the location in which a threatening stimulus was presented previously compared to when the probe is presented on the location in which a neutral stimulus was presented previously. Participants can be trained to attend away from negative stimuli by presenting the probe on the location of the neutral picture in a majority of the trials.

Such attentional retraining has been shown to reduce symptoms of social anxiety (e.g. Amir, Weber, Beard, Bomyea, & Taylor, 2008; Schmidt, Richey, Buckner, & Timpano, 2009) and generalized anxiety disorder (e.g. Amir, Beard, Burns, & Bomyea, 2009). Nevertheless, the effectiveness of attentional retraining in counteracting anxiety is still a highly debated topic. First, it does not seem effective in reducing all forms of anxiety, such as spider phobia (Reese, McNally, Najmi, & Amir, 2010; Van Bockstaele, Verschuere, Koster, Tibboel, De Houwer, & Crombez, 2011). Second, the attentional retraining effect does not seem to generalize across different tasks. Van Bockstaele, Koster, Verschuere, Crombez, and De Houwer (2012), for instance, found that the reduction of attentional bias through the modified dot probe task did not become apparent when measured with an emotional interference task. Third, attentional retraining does not seem to affect the early, automatic components of attentional bias, but rather its late, more controlled components (Koster, Baert, Bockstaele, and De Raedt, 2010). Attention seems to be directed primarily to threatening stimuli, whereas it can be directed away from threat only later. Attentional retraining therefore does not seem to alter the most important processes underlying attentional bias and anxiety as such.

Perhaps a reason for such ambiguous results involves FSAA. While participants are trained to direct spatial attention away from a threatening stimulus, they might still have attended to the affective stimulus dimension. After all, attending away from a specific stimulus requires one to identify the stimulus first. In the case of attentional retraining, attention towards the affective stimulus dimension can aid participants in identifying the threatening stimulus to direct spatial attention away from it. A more suitable way to alter processes underlying anxiety might be to train one to attend away from the affective stimulus dimension instead of attending away from the spatial location of the affective stimulus. Such feature-specific attentional retraining could change the early, automatic processes underlying attentional bias and might prove more beneficial in reducing symptoms of anxiety as such. Preliminary evidence for feature-specific attentional retraining can be found in Chapter 2. Manipulations of FSAA seem to be able to change attentional bias. It remains to be seen, however, whether such manipulations affect early, automatic components of attentional bias, whether feature-specific attentional retraining can easily be accomplished, and whether it also reduces symptoms of anxiety.

CONCLUSION

Over the past four years, we systematically tested several predictions stemming from the framework of FSAA (Spruyt et al., 2009). According to this framework automatic affective stimulus processing is dependent on the extent to which affective stimulus information is selectively attended to. We first demonstrated that FSAA can be instigated by subtle characteristics of the experimental procedure. We then further corroborated the framework by showing that FSAA affects various consequences of affective stimulus processing. In a final study, multidimensional scaling was put forward as a possible method that allows for the measurement FSAA. This method could be used in future research to assess whether automatic affective stimulus processing is linearly dependent on FSAA. Our research and future research on FSAA can contribute to our understanding in a variety of important research domains such as attitude measurement and attentional retraining in attentional bias.

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NEDERLANDSTALIGE SAMENVATTING

Reeds in het begin van de vorige eeuw stelden verschillende invloedrijke auteurs dat mensen over een mechanisme beschikken dat elke stimulus die waargenomen wordt onconditioneel en automatisch evalueert (e.g., Arnold, 1960; Bartlett, 1932; Lazarus, 1966; Wundt, 1907). Zo een veronderstelling lijkt niet meer dan logisch, aangezien een automatische evaluatie van een stimulus het verschil kan betekenen tussen leven en dood. Een diepgaande experimentele analyse van "affectieve prikkelverwerking" liet echter op zich wachten tot de jaren tachtig, dankzij het invloedrijke werk van Zajonc (1980, 1984).

Het bestuderen van affectieve prikkelverwerking vereist methoden die ons toelaten om dit mentale proces adequaat te meten. In de gedragswetenschappen is het affectieve priming paradigma met alle waarschijnlijkheid het meest populaire paradigma dat wordt gebruikt om affectieve prikkelverwerking te bestuderen (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). Tijdens de affectieve priming taak worden deelnemers gevraagd om verschillende affectief gepolariseerde "doelprikkels" te categoriseren als zijnde "positief" of "negatief" (i.e. de affectieve categorisatietaak). Elke doelprikkel wordt voorafgegaan door de korte presentatie van een affectief gepolariseerde "primeprikkel" die niet relevant is voor het uitvoeren van de taak. Hoewel de prime taakirrelevant is, beïnvloedt diens affectieve waarde systematisch de taakprestaties. Deelnemers voeren de taak doorgaans beter uit wanneer de prime en de target tot dezelfde affectieve categorie behoren (bv. de woorden "vriend" en "puppy") dan wanneer ze tot verschillende affectieve categorieën behoren (bv. de woorden "vriend" en "verkrachter"). Dit "affectieve priming effect" kan enkel voorkomen wanneer de affectieve waarde van de primeprikkel verwerkt werd en dient bijgevolg als maat voor de affectieve verwerking van de primeprikkel.

Recent experimenteel onderzoek waarin o.a. het affectieve priming paradigma werd gebruikt heeft inderdaad bevestigd dat affectieve prikkelverwerking de kenmerken van een automatisch proces bevat. Een proces wordt doorgaans als automatisch beschouwd wanneer het snel is en onafhankelijk verloopt van cognitieve capaciteit, bewustzijn en de huidige doelen (voor een review over automaticiteit, zie Moors & De Houwer, 2006). Deze kenmerken kwamen systematisch naar boven in onderzoek met het affectieve priming paradigma. Hun bestaan werd afgeleid uit het feit dat het affectieve priming effect toch geobserveerd werd onder tal van condities die de verwerking van de prime significant moeilijker maakten. Zo concludeerden Hermans, De Houwer en Eelen (2001) dat affectieve stimulusverwerking snel verloopt omdat affectieve priming effecten gevonden werden zelfs wanneer de doelprikkel de primeprikkel zeer snel opvolgde (reeds na 150 ms). Hermans, Crombez en Eelen (2001) toonden dan weer aan dat affectieve prikkelverwerking niet afhankelijk is van cognitieve capaciteit en dus heel efficiënt verloopt. Affectieve priming effecten werden immers gevonden wanneer tezelfdertijd een moeilijke tweede taak werd uitgevoerd die de cognitieve hulpbronnen zwaar taxeerde. In andere studies werd aangetoond dat affectieve prikkelverwerking gebeurt zelfs voor prikkels die niet bewust waargenomen worden (Draine & Greenwald, 1998; Greenwald, Draine, & Abrams, 1996). Zo werden affectieve priming effecten gevonden wanneer de primeprikkel niet bewust werd waargenomen. Affectieve prikkelverwerking bleek ook onafhankelijk te zijn van een expliciet evaluatief verwerkingsdoel (Bargh, Chaiken, Raymond, & Hymes, 1996; Hermans, De Houwer, & Eelen, 1994). Wanneer een taak gebruikt werd die geen expliciete evaluatie vereiste, namelijk het benoemen van de doelprikkel, werden affectieve priming effecten nog steeds geobserveerd.

Ook in de neurowetenschappen werden gelijkaardige indicaties van affectieve prikkelverwerking als automatische proces vastgesteld. Hier werd eveneens vastgesteld dat affectieve prikkels neurale activiteit heel vroeg beïnvloedden (bv. Carretié, Hinojosa, Martin-Loeches, Mercado, & Tapia, 2004), zelfs wanneer een moeilijke tweede taak werd aangeboden (bv. Hajcak, Dunning, & Foti, 2007), wanneer de stimulus niet bewust verwerkt werd (bv. Vuilleumier, Armony, Driver, & Dolan, 2001), en wanneer taken werden gebruikt die geen evaluatief verwerkingsdoel vereisten (bv. Schupp, Junghöfer, Weike, & Hamm, 2003; Vuilleumier et al., 2001).

Hoewel de bovenvermelde studies overtuigende evidentie vormden voor affectieve prikkelverwerking als onconditioneel en automatisch proces, verschenen er verschillende andere studies waarin dit niet zo bleek te zijn. Zo heerst er bijvoorbeeld nog steeds enige discussie over de rol van een expliciet evaluatief verwerkingsdoel in affectieve prikkelverwerking. Hoewel enkele onderzoekers initieel affectieve priming effecten observeerden wanneer men de doelprikkels louter diende te benoemen (Bargh et al., 1996; Hermans et al., 1994), kon niet iedereen deze effecten repliceren (Klauer & Musch, 2001; Spruyt, Hermans, Pandelaere, De Houwer, & Eelen, 2004). Ook in de neurowetenschappen heerst er geen consensus over de onconditionaliteit en automaticiteit van affectieve prikkelverwerking (bv. Pessoa, 2005).

Spruyt, De Houwer en Hermans (2009; zie ook Spruyt, De Houwer, Hermans, & Eelen, 2007; Spruyt, De Houwer, Everaert, & Hermans, 2012) stelden recent een verklaring voor deze inconsistente bevindingen voor. Zij suggereerden dat automatische affectieve prikkelverwerking sterk afhankelijk is van kenmerkspecifieke aandachtstoewijzing. Affectieve prikkelverwerking werd verondersteld enkel te gebeuren wanneer selectief aandacht wordt besteed aan affectieve prikkelinformatie. Wanneer selectieve aandacht wordt besteed aan niet-affectieve prikkelinformatie, wordt echter geen automatische affectieve prikkelverwerking verwacht maar een diepere verwerking van deze niet-affectieve prikkelinformatie. Verschillende studies boden evidentie voor deze verklaring. In één dergelijke studie, werd het affectieve priming paradigma gebruikt om automatische affectieve prikkelverwerking te meten. Tijdens 25 % van de experimentele beurten voerden de deelnemers de bovenvermelde benoemingstaak uit op de doelprikkels. Tijdens de overige 75 % van de beurten voerde één groep deelnemers (de affectieve groep) de affectieve categorisatietaak uit terwijl een andere groep deelnemers (de niet-affectieve groep) een niet-affectieve, semantische categorisatietaak uitvoerde. Deze groep werd gevraagd te beslissen of de doelprikkels duidden op een dier of een object. De categorisatietaak werd steeds gebruikt als middel om de deelnemers aan te moedigen tot het besteden van aandacht aan affectieve prikkelinformatie in de affectieve groep of niet-affectieve, semantische prikkelinformatie in de niet-affectieve groep. In overeenstemming met de verklaring van kenmerkspecifieke aandachtstoewijzing werd affectieve priming van benoemingsresponsen enkel gevonden in de affectieve groep. In de niet-affectieve groep werd echter semantische priming van benoemingsresponsen geobserveerd. De deelnemers van deze groep presteerden beter wanneer de doelprikkel en de primeprikkel tot dezelfde semantische categorie (dier of object) behoorden dan wanneer deze niet tot dezelfde semantische categorie behoorden. Deze modulatie door kenmerkspecifieke aandachtstoewijzing werd teruggevonden in tal van studies (Spruyt et al., 2007, 2009) en was zelfs van kracht wanneer de primeprikkels niet bewust werden waargenomen (Spruyt et al., 2012).

OVERZICHT VAN HET PROJECT

De bovenvermelde studies vormden de eerste evidentie voor kenmerkspecifieke aandachtstoewijzing als cruciale factor in automatische affectieve prikkelverwerking. Uit deze verklaring volgen echter nog enkele predicties die systematisch getoetst werden in het project.

Subtiele aspecten van de experimentele procedure beïnvloeden kenmerkspecifieke aandachtstoewijzing

Een eerste predictie betreft de mogelijke factoren die kenmerkspecifieke aandachtstoewijzing voor affectieve prikkelinformatie kunnen beïnvloeden. Volgens Spruyt et al.’s (2007, 2009, 2012) verklaring komt automatische affectieve prikkelverwerking enkel voor wanneer men selectieve aandacht besteedt aan affectieve prikkelinformatie. Bijgevolg impliceren effecten van automatische affectieve prikkelverwerking dat affectieve prikkelinformatie noodzakelijkerwijs selectieve aandacht toegewezen kreeg. In verschillende studies werd affectieve priming van benoemingsresponsen echter gevonden zonder expliciete manipulaties van selectieve aandacht (e.g. Bargh et al., 1996; Hermans et al., 1994). Mogelijks beïnvloeden subtiele aspecten van de experimentele procedure van deze studies de deelnemers impliciet tot het aandacht schenken aan affectieve prikkelinformatie. Dergelijke aspecten omvatten o.a. het opvallend gebruik van affectief gepolariseerde prikkels, de verwoording van de instructies, de informatie in het informed consent formulier, kennis van het onderzoek dat in het specifieke lab gebeurt, enzovoort.

In **Hoofdstuk 1**, werd nagegaan of één van deze aspecten, namelijk het opvallend gebruik van affectief gepolariseerde prikkels, daadwerkelijk kenmerkspecifieke aandachtstoewijzing beïnvloedt. In een studie pasten we hiervoor het affectieve priming paradigma toe waarin de benoemingstaak werd gebruikt. Een vierde van alle beurten bestond uit dergelijke affectieve priming beurten. Deze "experimentele beurten" werden samen aangeboden met andere "contextbeurten" die affectief gepolariseerde prikkels bevatten in één groep deelnemers (de affectieve groep) en affectief neutrale prikkels bevatten in een andere groep deelnemers (de niet-affectieve groep). In de affectieve groep werden de deelnemers bijgevolg blootgesteld aan een hoge proportie affectief gepolariseerde prikkels. In de niet-affectieve groep daarentegen werden de deelnemers blootgesteld aan een lage proportie affectief gepolariseerde prikkels. Volgens de verklaring van kenmerkspecifieke aandachtstoewijzing zou de hoge proportie affectief gepolariseerde prikkels in de affectieve groep de deelnemers ertoe aanmoedigen om aandacht te schenken aan affectieve prikkelinformatie. In de niet-affectieve groep zou de lage proportie affectief gepolariseerde prikkels affectieve prikkelinformatie net minder opvallend maken, waardoor er minder aandacht aan geschonken zou worden. In overeenstemming met deze verklaring werd affectieve priming van benoemingsresponsen enkel geobserveerd in de affectieve groep. Bijgevolg lijken subtiele aspecten van de experimentele procedure voldoende te zijn om selectieve aandacht voor affectieve prikkelinformatie te induceren zonder expliciete manipulaties van aandacht.

Kenmerkspecifieke aandachtstoewijzing beïnvloedt de gevolgen van automatische affectieve prikkelverwerking

Een tweede predictie betreft de effecten van kenmerkspecifieke aandachtstoewijzing op gevolgen van automatische affectieve prikkelverwerking. In eerdere studies werd de invloed van kenmerkspecifieke aandachtstoewijzing steeds aangetoond met het affectieve priming paradigma. In dit paradigma wordt automatische affectieve prikkelverwerking steeds gemeten via één of meerdere van diens gevolgen op andere processen of gedrag. Het affectieve priming paradigma waarin de benoemingstaak wordt gebruikt laat ons bijvoorbeeld toe automatische affectieve prikkelverwerking te meten omdat affectieve prikkels het coderen van affectief congruente prikkels faciliteren (bv. Spruyt et al., 2007). Aangezien verondersteld wordt dat kenmerkspecifieke aandachtstoewijzing automatische affectieve prikkelverwerking beïnvloedt, kan echter gesteld worden dat elk mogelijk gevolg van automatische affectieve prikkelverwerking eveneens beïnvloed wordt door kenmerkspecifieke aandachtstoewijzing.

In **Hoofdstuk 2** werd daarom de impact van kenmerkspecifieke aandachtstoewijzing op een ander gevolg van automatische affectieve prikkelverwerking nagegaan, namelijk het vermogen van een affectieve stimulus tot het trekken van aandacht (voor reviews, zie Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Yiend, 2010). Een dergelijke aandachtsbias kan gemeten worden met verschillende paradigma's. In de *emotionele Stroop-taak* (Pratto & John, 1991, Williams, Mathews, & MacLeod, 1996) bijvoorbeeld, worden deelnemers gevraagd de kleur te benoemen van verschillende sequentieel gepresenteerde woorden waarvan de betekenis taakirrelevant is. Prestaties zijn doorgaans slechter wanneer de connotatie van de woorden negatief is dan wanneer deze neutraal is. Dit emotionele Stroopeffect wordt verondersteld tot stand te komen omdat de negatieve, taakirrelevante betekenis van de woorden de aandacht wegtrekt van de taakdoelen. De *dot probe taak* is een andere populaire taak die eveneens vaak gebruikt wordt voor het meten van affectieve aandachtsbias (MacLeod, Mathews, & Tata, 1986). In deze taak worden deelnemers gevraagd te reageren op de locatie van zgn. dot probes, simpele perceptuele prikkels (bv. een klein vierkant, een punt, …). De presentatie van elke dot probe wordt voorafgegaan door de presentatie van een negatief en een neutraal beeld die elk op een andere locatie in het scherm verschijnen. Prestaties zijn gewoonlijk beter wanneer de dot probe verschijnt op de locatie waarop eerder een negatief beeld gepresenteerd werd dan op de locatie waarop eerder een neutraal beeld gepresenteerd werd. Dit effect zou tot stand komen omdat het negatieve beeld aandacht trekt naar diens positie en zo het verdere lokaliseren van de dot probe beïnvloedt.

In twee experimenten werd kenmerkspecifieke aandachtstoewijzing gemanipuleerd terwijl aandachtsbias gemeten werd met de emotionele Strooptaak (Experiment 1) en de dot probe taak (Experiment 2). Tijdens de helft van de beurten werden de deelnemers gevraagd een categorisatietaak uit te voeren. Deze taak werd gebruikt om de deelnemers aan te moedigen tot het besteden van aandacht aan affectieve prikkelinformatie in één groep deelnemers (de affectieve groep) of niet-affectieve prikkelinformatie in een andere groep deelnemers (de niet-affectieve groep). In de affectieve groep werden de deelnemers gevraagd prikkels te categoriseren als zijnde “negatief” of “niet negatief”. In de niet-affectieve groep werden de deelnemers gevraagd prikkels te categoriseren als zijnde “mens” of “niet mens”. Tijdens de andere helft van de beurten voerden de deelnemers de emotionele Strooptaak (Experiment 1) of de dot probe taak (Experiment 2) uit. In overeenstemming met de bovenvermelde predictie bleken de maten voor aandachtsbias eveneens gevoelig aan een manipulatie van kenmerkspecifieke aandachtstoewijzing. Een aandachtsbias voor negatieve prikkels werd enkel vastgesteld in de affectieve groepen. Bovendien werden indicaties voor een aandachtsbias voor niet-affectieve prikkels vastgesteld in de niet-affectieve groepen. In deze groep leken prikkels die duidden op mensen de aandacht te trekken.

In **Hoofdstuk 3** werd de impact van kenmerkspecifieke aandachtstoewijzing op een andere, neurale manifestatie van aandachtsbias nagegaan. Wanneer een sequentie prikkels op voorspelbare wijze aangeboden wordt, trekt een onverwachte prikkel aandacht naar zich toe. Deze aandachtsbias kan gemeten worden met behulp van EEG metingen en manifesteert zich als een ERP component die de P3a genoemd wordt (Polich, 2007). Deze component blijkt gevoeliger te zijn voor emotionele veranderingen dan voor niet-emotionele veranderingen in prikkels (Campanella et al., 2002). In een EEG studie werd een sequentie gezichten gepresenteerd van middelbare leeftijd met neutrale gelaatsexpressies. Occasioneel werden afwijkende gezichten aangeboden die blij, droevig, jong of oud konden zijn. Eén groep deelnemers (de affectieve groep) werd gevraagd te reageren wanneer een blij of droevig gezicht verscheen. Bijgevolg werd deze groep aangemoedigd tot het besteden van aandacht aan affectieve prikkelinformatie. Een andere groep deelnemers (de niet-affectieve groep) werd gevraagd te reageren wanneer een jong of oud gezicht verscheen. Derhalve werd deze groep aangemoedigd tot het besteden van aandacht aan niet-affectieve prikkelinformatie. Wederom beïnvloedde kenmerkspecifieke aandachtstoewijzing de aandachtsbias zoals gemeten via de P3a. Een significante P3a voor emotioneel onverwachte prikkels werd enkel geobserveerd in de affectieve groep. Indicaties voor een P3a voor prikkels met een onverwachte leeftijd daarentegen, werden enkel geobserveerd in de niet-affectieve groep.

Aldus lijken de gevolgen van automatische affectieve prikkelverwerking eveneens gevoelig voor kenmerkspecifieke aandachtstoewijzing.

Het meten van kenmerkspecifieke aandachtstoewijzing

De bovenvermelde studies van Spruyt et al. (2007, 2009, 2012) en de studies die werden uitgevoerd in dit project kennen een algemene beperking. Tot nu toe werd nooit een onafhankelijke maat van kenmerkspecifieke aandachtstoewijzing afgenomen en werd er dus geen manipulatiecheck opgenomen in het experimentele design. De doeltreffendheid van de manipulatie werd slechts afgeleid uit diens effect op maten van automatische affectieve prikkelverwerking. Kenmerkspecifieke aandachtstoewijzing werd echter nooit direct gemeten en er kan dus niet met zekerheid aangenomen worden dat de manipulatie daadwerkelijk kenmerkspecifieke aandachtstoewijzing beïnvloedde. Tot nu toe zijn er echter geen maten bekend die regelmatig worden toegepast in de praktijk.

In **Hoofdstuk 4** werd een mogelijke maat voor kenmerkspecifieke aandachtstoewijzing gevalideerd. De maat betreft INDSCAL, een speciale toepassing van multidimensionale schalering (Carroll & Chang, 1970). In deze methode worden gelijkenisoordelen van paren prikkels gebruikt om er een multidimensionale voorstelling van te bekomen. De prikkels worden voorgesteld in een ruimte met verschillende dimensies die corresponderen met de kenmerken die de prikkels definiëren (bv. emotie, leeftijd, geslacht, …). Kenmerkspecifieke aandachtstoewijzing wordt in deze voorstelling gerepresenteerd door het wegen van de verschillende prikkeldimensies. Als een prikkeldimensie aandacht toegewezen krijgt, wordt deze uitgerekt in de ruimte waardoor prikkelverschillen met betrekking tot deze dimensie meer opvallen en gemakkelijker verwerkt worden. Een prikkeldimensie die geen aandacht toegewezen krijgt daarentegen, krimpt in de ruimte waardoor prikkelverschillen met betrekking tot deze dimensie net minder opvallen en moeilijker verwerkt worden. In een experiment werd kenmerkspecifieke aandachtstoewijzing gemanipuleerd terwijl het gemeten werd met het INDSCAL algoritme. Wederom werd de deelnemers gevraagd een categorisatietaak uit te voeren op de helft van de beurten. Een groep deelnemers (de affectieve groep) beoordeelde of aangeboden gezichten een blije of droevige gelaatsexpressie hadden terwijl een andere groep deelnemers (de niet-affectieve groep) beoordeelde of aangeboden gezichten er jong of oud uitzagen. Bijgevolg werd de affectieve groep aangemoedigd tot het besteden van aandacht aan de affectieve prikkeldimensie en werd de niet-affectieve groep aangemoedigd tot het besteden van aandacht aan een niet-affectieve prikkeldimensie gerelateerd aan leeftijd. Op de andere helft van de beurten werden paren gezichten aangeboden waarvan de deelnemers werd gevraagd hun gelijkenis te beoordelen op een schaal die ging van zeer verschillend tot zeer gelijkend. Deze gelijkenisoordelen zijn “psychologische” afstanden die werden gebruikt voor het creëren van een mentale, multidimensionale kaart waarin de gezichten gerepresenteerd worden. De oplossing die zo bekomen werd met INDSCAL bleek inderdaad gevoelig aan een manipulatie van kenmerkspecifieke aandachtstoewijzing. De prikkeldimensies waartoe selectieve aandacht aangemoedigd werd, werden uitgerokken in de multidimensionale ruimte. In toekomstige studies zou deze methode toegepast kunnen worden als manipulatiecheck.

DISCUSSIE

In het project werden verschillende predicties getoetst die volgden uit de hypothese dat automatische affectieve prikkelverwerking slechts plaatsvindt wanneer selectief aandacht wordt besteed aan affectieve prikkelinformatie (Spruyt et al., 2007, 2009, 2012). De huidige studies toonden aan dat subtiele aspecten in de omgeving kenmerkspecifieke aandachtstoewijzing kunnen sturen, en dat de effecten van kenmerkspecifieke aandachtstoewijzing op automatische affectieve prikkelverwerking zich ook uitbreiden naar de gevolgen van automatische affectieve prikkelverwerking. Verder werd een methode gevalideerd die het in de toekomst mogelijk maakt om kenmerkspecifieke aandachtstoewijzing op een onafhankelijke wijze te meten. Een dergelijke methode kan in toekomstige studies gebruikt worden als manipulatiecheck.

Het denkkader van kenmerkspecifieke aandachtstoewijzing heeft ook enkele gevolgen voor onderzoek en diens praktische toepassingen. Volgens het denkkader van kenmerkspecifieke aandachtstoewijzing wordt de verwerking van elke prikkeldimensie gefaciliteerd als er aandacht aan geschonken wordt, ongeacht of de prikkeldimensie affectief is of niet. Elke fenomeen dat gekenmerkt wordt door de verwerking van prikkels of prikkelkenmerken is dus tot op een zekere hoogte afhankelijk van kenmerkspecifieke aandachtstoewijzing. Zo speelt kenmerkspecifieke aandachtstoewijzing naar alle waarschijnlijkheid een rol in de activatie van attitudes, stereotypes, en automatische associaties. Voor het gebruik van deze constructen in praktische toepassingen, zoals het voorspellen van gedrag op basis van attitudes, dient men bijgevolg rekening te houden met kenmerkspecifieke aandachtstoewijzing. Het denkkader heeft ook enkele klinische implicaties. Zo kan kenmerkspecifieke aandachtstoewijzing een grote rol spelen in fobieën en angststoornissen. Populaties met dergelijke stoornissen schenken intensief aandacht aan affectieve- of stoornisrelevante prikkelinformatie. Een dergelijke aandachtsbias speelt mogelijks een cruciale rol in deze psychopathologische vormen (Mogg & Bradley, 1998). Het veranderen van deze aandachtsbias zou bijgevolg een gunstig effect kunnen hebben op de geassocieerde stoornis. In toekomstig onderzoek zou men kunnen nagaan of het trainen tot het schenken van aandacht aan niet-affectieve prikkelinformatie gunstige effecten kan hebben voor populaties met fobieën en angststoornissen. Verder onderzoek naar kenmerkspecifieke aandachtstoewijzing zou dus onze kennis over fenomenen zoals attitudes en angststoornissen kunnen verbeteren.

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