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The Effect of Automatic vs. Reflective Emotions on Cognitive Control in Antisaccade Tasks and the Emotional Stroop Test

Abstract *The article presents two studies based on the assumption that the effectiveness of cognitive control depends on the subject's type of emotional state. Inhibitory control is taken into account, as the basic determinant of the antisaccade reactions and the emotional Stroop effect. The studies deal with differentiation of emotions on the basis of their origin: automatic (due to primary affective reactions) vs. reflective (due to deliberative evaluation). According to the main assumption, automatic emotions are diffusive, and decrease the effectiveness of cognitive control. The hypothesis predicted that performance level of both the Antisaccade Task and the Emotional Stroop Test would be lower in the automatic-emotion eliciting condition than in the reflective-emotion eliciting condition. In two experimental studies, positive and negative (automatic vs. reflective) emotions were elicited. The results support the predictions, regardless of the valence of emotions.*

Keywords: *sensory vs. conceptual base of emotion, primary and secondary affect, affect diffusiveness, voluntary control*

In the course of the psychological and neurobiological debate on the *emotion - cognition* relationship, the role of the emotional valence is a frequently analyzed attribute (e. g. Ashby, Isen & Turken, 1999; Dreisbach & Goschke, 2004; Isen, 1990, 1999; Mitchell & Phillips, 2007). Some authors distinguish two separate evaluative systems (negative vs. positive) and describe the so-called positive-negative asymmetry in their regulative functions (Cacioppo & Gardner, 1999; Peeters & Czapiński, 1990). However, negative as well as positive emotions can have clearly distinctive origins. A common valence (negative or positive) may have relatively little meaning in the consequences of different types of emotions. The same type of affect can have different sources and regulative roles. Joy could be due to gratification of biological needs, one's own success or somebody else's failure. Anxiety can be evoked by the loss of a job or by worry and fear concerning the future of the world. Obviously the mechanisms and functions of such different emotions have to be incomparable to some extent, even if the sign of the affective component is the same. There are important reasons to assume that the question about the influence of emotions on cognition and behavior needs further clarification concerning the differentiation of the origins of the emotions.

Differentiation of the automatic vs. reflective origin of negative and positive emotions

To differentiate the origin of negative and positive emotions, we refer (Jarymowicz, 2009a, 2009b; Jarymowicz & Imbir, 2010) to some selected theories and empirical data that help in understanding universal as well as specifically human emotions. The first category of emotions is similar in human beings and other animals. This category is based on automatic sensory regulation and the primary affects due to homeostatic and hedonic standards. Those emotions

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arise due to the internal equilibrium of the organism and subjective well-being (Oatley & Jenkins, 1996; Plutchik, 1980). The second is specifically human category of emotion, based on an intellectual understanding of the meaning of objects, states, and events. All of those processes leads to deliberative judgments and secondary affect (Piaget, 1965, 1981; Reykowski, 1968, 1985; Zajonc, 1980, 1984, 1994). These fundamental distinctions seem to be connected with the "heart and mind" dichotomy, included in the traditional view of human nature. The two mentioned categories of emotions allow us to extend the debate on human emotions from the narrow, sensory S – R perspective, and to include various important sources of emotions. For example those due to reflection on the past, thinking about the future, and – moreover – about non-existing, possible, anticipated states of reality.

Neurobiological and psychological bases of automatic vs. reflective emotions

In our studies on the automatic vs. reflective origin of emotions, we refer to Janusz Reykowski's theory of emotions (Reykowski, 1968, 1985, 1989), and his distinction between affective reactions vs. deliberative judgments as evaluative processes of two main, different types. This distinction is coherent with a larger perspective on the regulatory systems of human functioning, and distinctions between *automatic* vs. *controlled* processes (Schneider & Shiffrin, 1977) or *impulsive* vs. *reflective* systems (Deutsch, Gawronski & Strack, 2006). Reykowski (1989) added to this division an important question: what is the basis for evaluation within the reflective system?

The distinction between automatic vs. controlled processes has a solid foundation in neurobiological knowledge. The literature on brain mechanisms of emotions differentiates the role of the subcortical vs. cortical processes leading to emotions (Arnold, 1968; Damasio, 1994; Lindquist, Wager, Kober, Bliss-Moreau & Barrett, 2012; Panksepp, 1998; Russel & Barrett, 1999; Sander, Grafman & Zalla, 2003; Sander, Grandjean & Scherer, 2005; Zagrodzka, 2011). The model of the "emotional brain" by Joseph LeDoux (1994, 1996) and his description of the "survival circuits" in the brain (LeDoux, 2012) helps to distinguish between emotions common for humans and animals and emotions that are specifically human. According to Panksepp (1998; 2005) there is no reason to talk about human emotions only in reference to the limbic system. Gazzaniga (2011), in his recent monography, argues: "We are people, not brains" (p. 218).

From the psychological perspective, human emotions are based on unconscious or conscious appraisals (Sander & Scherer, 2009). Even explicit evaluation can be due to implicitly evoked primary affects (Berridge & Winkielman, 2003; Greenwald & Banaji, 1995; Jarymowicz, 2006; Murphy & Zajonc, 1993; Nosek & Banaji, 2002; Ohme, 2007). On the other hand, however, explicit evaluation can also be due to affect-independent judgments, based on intellectual analyses of the meaning of different stimuli and symbols. This distinction of evaluations (based on primary affects vs. articulated appraisal) is included in Robert Zajonc's classic theory of emotions (1980, 1994). The model (see Zajonc, 1980: Figure 5) differentiates preferences that "need no inferences" and emotions due to cold cognition (stimulus recognition, analyzing the features of a stimulus), leading to secondary affective reactions. Reykowski differentiates between automatic primary affective reactions to a stimulus and emotions due to deliberative appraisals based on articulated evaluative standards (Reykowski, 1968, 1985, 1989).

Reflective processes are crucial in this type of evaluation (Deutsch, Gawronski & Strack, 2006; Gawronski & Strack, 2012). Modern theories highlight the role of appraisal in emotional processing (Scherer, 2001, 2004; Scherer, Schorr & Johnstone, 2001). But we must distinguish between automatic appraisals and articulated concepts as sources of appraisals leading to emotions. The latter have to be included in the theoretical framework and studies on specifically human emotions (Wierzbicka, 1999, 2009). Moreover, more attention must be paid to the intellectual basis of evaluation, and to the abstract axiological concepts linking emotions with ideas and ideals – heuristics of what is good or bad.

A taxonomy of human emotions: the basis for the present studies

In our studies on emotions we refer to the assumption that there are two evaluative systems: the *automatic evaluative system* and the *reflective evaluative system* (Jarymowicz, 2001, 2009b), and each one generates negative and positive emotions of different origin, regulative functions and consequences. We postulate a taxonomy of emotions including four categories of mechanisms leading to the elicitation of human emotions (Jarymowicz & Imbir, 2010, 2011, submitted).

We assume that inside each of the evaluative systems, the (primary) automatic one and the reflective one, negative and positive emotions are evoked by internal and external stimuli of significantly different types.

I. In the automatic evaluative system, emotions are related to the internal or external sensory stimuli leading to primary affective reactions;

(1) internal sources are due to biological and psychological homeostasis: to states of deprivation vs. gratification of biological as well as psychological drives and needs (such as social belonging or social acceptance - *type D needs* in terms of Maslow, 1954) and

(2) external sources are due to incentives of aversive or hedonic nature.

II. In the reflective evaluative system, emotions are based on conceptualizations of what is bad or good;

(1) internal sources are due to articulated self-standards: the valence of emotions depends on violation/realization of personal standards, and

(2) external - transgressive sources (crossing the borders of the self perspective) are related to the confrontation of states of reality with abstract axiological concepts of good and evil.

Automatic emotions, due to biological/social reinforcements and hedonic or aversive kinds of external stimulation, are universal, shared with other people as well as (to some extent) with animals. Reflective emotions are specific to human beings but not universal, since they are based on abstract evaluative standards, whose formation requires personal effort and reflective, intellectual activity (Piaget, 1981; Reykowski, 1989; Wierzbicka, 2009). This type of emotion can be evoked only if an individual is not only able to understand abstract concepts, but also to perceive their designates and connections with different attributes of reality. Such abilities can lead to a new type of ego-involvement and emotions- like enthusiasm for a given political stand, promoting human rights and different religious views (ecumenism), defending the environment and so on.

Automatic vs. reflective types of emotion lead to different consequences. The difference that is most important for the present article, concerns their diffusive vs. precise nature. In particular, the automatic emotions ("affective reactions bypassing the will") are, according to Zajonc (1980) " inescapable (…), they cannot be focused (…), they are holistic (…) and thus less subject to control attentive processes" (p. 156). In other words, they are uncontrolled and diffusive, leading to holistic, homogenous, "black or white" evaluations of a whole situation (Murphy & Zajonc, 1993; Ohme, 2007; Plutchik, 1980; Zajonc, 1984, 1994, 2000). The reflective emotions are related to distinct objects, and their particular attributes are cognitively differentiated, analyzed and evaluated (Jarymowicz, 2008; Stapel, Koomen & Ruys, 2002; Zajonc, 1980). Reflective emotions allow us to perceive negative as well as positive attributes in the same object, which is impossible when the automatically evoked primary affects operate. Thanks to these affect-independent reflective standards, the positive emotions can motivate us to exert effort – which is itself unpleasant and, as such, would be considered negative within the automatic evaluative system.

The type of emotion and cognitive control: the hypothesis of the present studies

Cognitive control plays the role of a very powerful determinant of human behavior (Banich, 2009; Dreisbach & Goschke, 2004; Falkowski, Maruszewski & Nęcka, 2008; MacLeod, 2007a, 2007b; Mitchell & Phillips, 2007; Nęcka, Orzechowski & Szymura, 2008; Tarnowski, 2009), as well as a factor influencing cognitive processes such as perception, reasoning, thinking, and memory (Chuderski & Orzechowski, 2005). Its effectiveness depends on the emotional state of the subject. An important question arises: what type of emotion limits the capacity of cognitive control? Could we formulate any prediction in reference to the aforementioned taxonomy of human emotions?

It seems that the most important basis for the dependence of cognition on emotions is affective primacy. Psychological as well as neurobiological data show that the affective reaction to an external stimulus can be evoked earlier than its explicit recognition, evaluation, and behavior (Damasio, 1994; Jarymowicz, 2006; Kolańczyk, 2001; LeDoux, 1996; Murphy & Zajonc, 1993; Ohme, 2007; Panksepp, 1998; Payne, Cheng, Govorun & Stewart, 2005; Zajonc, 1980). Therefore, affect can influence attention, perception, and thinking (Bargh, 1997; Murphy & Zajonc, 1993; Underwood, 1996; Zajonc, 1980). Moreover, the primary affect dominates interpretations, judgments, social categorizations and behavior (Bargh, 1997; Chen & Bargh, 1997; Greenwald & Banaji, 1995).

We assume that the domination of emotions on cognition and on cognitive control is due only to the automatic emotions. In the case of the automatic emotions, affect is evoked earlier than is explicit cognition of the stimulus, its meaning and one's own reaction. Moreover, such primary affect is diffusive, because this type of emotion (basic for the organism's equilibrium and survival in the physical and the social environment) leads to generalized arousal and mobilization (LeDoux, 2012). From the psychological point of view, this means that the source of a particular emotional state is given special concentration. Such concentration reduces flexibility of attention.

It seems that this type of emotion–cognition relationship does not concern the reflective emotions. This type of emotion is based on quite a different sequence of evaluative processes: intellectual recognition of the meaning of an object (situation, state or phenomena) precedes the (secondary) affective reaction. Moreover, the affective component of the reflective emotional reaction is precisely connected with a particular element of the situation and does not refer to irrelevant elements; a basic attribute of reflective emotions is selectivity.

We argue, thus, that the diffusive influence of emotions on cognition concerns only the type of emotions that we call automatic emotions, and does not concern reflective emotions. "When two similar stimuli are used in a conditioning study, the thalamus will send the amygdala essentially the same information, regardless of which stimuli it is processing. But when the cortex processes different stimuli, it will send to the amygdala different signals" (LeDoux, 1996, p. 163). In other words, on the primary level, descriptive and evaluative information processes are strictly interdependent. Independence becomes possible thanks to the mediated role of processes activated on the higher level of the brain's structures. Information processing becomes more selective. The reflective emotions are associated with such selective processes.

These general characteristics of the automatic vs. reflective emotions have different consequences for the controllability of the two types of emotions. This concerns not only the efficacy of the individual's control on emotional processes, but also on their influence on cognition and behavior.

The main issue of the presented studies is related to the role of different emotions as determinants of perception and cognitive control. We formulated questions about the impact of automatic vs. reflective emotions on cognitive control, specifically regarding the perceptual selectivity of signals. These studies were based on the assumption that automatic emotions – and not reflective ones - interfere strongly at the early stages of the information processing. The interference of the evoked emotions decreases selectively of perception of a target in the context of other objects.

We tried to verify this hypothesis by measuring the effectiveness of two types of cognitive control: oculomotor inhibition and the interference control (Nigg, 2000). To measure oculomotor inhibition, we used the Antisaccade Task (Hallet, 1978). This task permits us to examine the effectiveness of the selective perception of a particular stimulus accompanied by a distractor. When a given distractor is more salient than the target, the level of performance depends on the effectiveness of voluntary control. This control leads to the decentration and the antisaccade reaction (Friedman & Miyake, 2004; Hallet, 1978; Miyake, Friedman, Emerson, Witzki, Howerter & Wager, 2000; Nigg, 2000; Roberts, Hager & Heron, 1994; Tarnowski, 2009). The Antisaccade Task may be particularly useful, because oculomotor inhibition is more difficult to control than is inhibition control associated with the Stroop Task (Nigg, 2000).

The interference control was measured by the Emotional Stroop Test (EST; McKenna & Sharama, 2005). The EST is based on the assumption that response times to the question about the color of printed letters of neutral words are shorter than the response times to emotional words, mainly negative ones (Borkenau & Mauer, 2006; McKenna & Sharma, 2004; Williams, Mathews & MacLeod, 1996). It is assumed that this effect is due to the rapid and automatic attraction of attention by the content of the emotional words. This attraction impedes the inhibition of the automated response (reading the words) and as a consequence it takes longer to answer the question of the letters' color. The main areas of application of the EST are clinical. Words associated with the source of trauma draw more attention, which results in longer time needed to complete task (see Williams, Mathews & MacLeod, 1996). In addition to the mainstream of clinical studies using the EST, there are reports in the literature confirming the general effect of reaction time increases in experimental studies using words connected to emotions (with no relation to a particularly traumatic experiences; McKenna & Sharma, 1995, 2004; Watts, McKenna, Sharrock & Trezise, 1986). Most of the data refer to words of negative affective connotations. However, the Stroop effect was observed even after positive words, though it was usually weaker (McKenna & Sharma, 1995; Pratto & John, 1991). This effect was often connected with words related to personal experience (McNally, Amir, Louro, Lukach, Riemann & Calamari, 1994). Because of its wide use in clinical applications we decided to use the EST instead of the classic Stroop task (Stroop, 1935).

Both studies, with the Antisaccade Task and the EST, were conducted to measure the effectiveness of cognitive control under conditions of different emotions' elicitation. Our hypothesis predicted that performance level of cognitive tasks (accuracy in Antisaccade Task and reaction time in EST) would be lower in conditions where automatic emotions were elicited than when reflective emotions were elicited.

The methods of eliciting automatic vs. reflective emotions

To verify our hypothesis, we had to elicit different automatic and reflective emotions. We decided to use verbal material. The reason for this choice is that some automatic emotions are clearly associated with particular labels. Reflective emotions, on the other hand, have no clear figurative form (Barrett, Lindquist & Gendron, 2007). We assumed that reading labels could stimulate recall of the specific affective reactions (LeDoux, 1996) – the components of various emotional processes. In other words, we assumed that concentration on the meaning of words related to emotional events or states, such like *danger, guilt* or *pride*, could evoke affective states. The attributes of the evoked states would be different in the case of words or sentences related to automatic emotions, than in the case of labels related to reflective emotions.

When looking for verbal material, we took into consideration that although there are numerous labels of emotion, not all are specifically associated with a particular category distinguished in our taxonomy of emotions. For instance, the label *joy* can be connected with some automatic emotions as well as with some reflective emotions. For this reason, we decided to use sets of words with similar emotional meanings. For example, a set of words like *illness, fame* and *pain* are more efficient at evoking homeostatic negative emotions, than would be the word *pain* used by itself. *Pain* without context could be associated with moral suffering, that is, with the reflective emotion. These sets of words were included in the EST, using the Antisaccade Task, we decided to use sets of sentences to elicit emotions. Sentence sets helped to make the manipulation longer and thus more salient than sets of words.

The verbal manipulations were based on the following assumptions: (1) content of evaluative labels or sentences can be associated with particular types of affects, (2) recalling content elicits an associated affect, (3) the use of a series of labels or sentences related to a particular category of emotions increases the reliability of the manipulation.

Before the main research started, we conducted a pilot study on the verbal material used to elicit emotions. We asked participants about the degree to which words are usually perceived as (a) excitatory and (b) important. The pilot study was carried out on a group of 100 students at the University of Warsaw. They had to assess words placed in a random order answering two questions using an 11-point Likert-type scale, where 0 indicated no excitation or importance, respectively, and 10 very high excitation or importance. Words referring to automatic emotions were assigned a higher degree of excitation than were words referring to reflective emotions (M_{Aut} = 6.1, *SD* = 2, M_{Refl} = 5.5, *SD* = 2.03, *F* (1, 99) = 63.859, *p* =.001). The same automatic emotion words were assigned a lower degree of importance than were words referring to reflective emotions M_{Aut} = 6.06, *SD* = 1.98, M_{Refl} = 6.5, *SD* = 2.4, *F* (1, 99) = 36.814, *p* = .001). These opposing results suggest the diversity of mechanisms of activation, which both types of emotions carry.

Study 1: The Antisaccade Task

The aim of Study 1 was to examine the hypothesis that automatic emotions influence oculomotor inhibition more than reflective ones do. The Antisaccade Task (Hallett, 1978; Miyake et al., 2000), used in Study 1, requires one to read, as quickly as possible, a single letter exposed randomly on the left or on the right side of the screen, when a salient distractor is visible on the opposite side. Participants have to shift their attention from a distractor to a letter, overcoming the strong tendency to gaze at the distractor. In other words, performance of the task requires oculomotor control (Nęcka, Orzechowski & Szymura 2008; Nigg, 2000). In the presented study, before the Antisaccade Task, we used sets of sentences associated with negative and positive emotions classified as automatic or reflective. The hypothesis predicted worse performance on the antisaccade task after eliciting automatic emotions than reflective emotions.

Participants

Eighty one individuals (65 females and 16 males) participated in the study. They were students from four different faculties of the University of Warsaw, Poland. Ages ranged from 19 to 24 (*M* = 21.35). Participation was voluntary. All participants spoke Polish as their mother tongue, had normal or corrected-to-normal vision, and normal color vision.

Materials and Method

We prepared four sets of sentences for negative and positive, automatic and reflective emotions. Table 1 presents English-equivalent example sentences from each category.

Table 1. *Examples of the sentences used to elicit different emotions, Study 1*

	Valence	
	Negative	**Positive**
AUTOMATIC emotions	*The worst diseases are those that develop while a person is unaware of the development.* *Sometimes we don't approach horrifying things because they are disgusting.*	*The return to calmness and tranquility after a period of stress is blissful.* *Lots of moments can be pleasant, but let's be honest, those from vacations are the best.*
REFLECTIVE emotions	*You can embarrass yourself and act in ways that will make you feel guilty.* *It is frightening when someone uses another for his or her own advantage.*	*Overcoming weaknesses is more satisfying than making excuses.* *Real satisfaction comes from cooperation based on human loyalty.*
NEUTRAL conditions	*Pure water freezes at 0 degrees C.*	

To elicit emotions (in Mixed Factorial Design, valence of emotion (2) as between subject factor and emotional system (2) as a within-subjects factor), we requested that participants read each set of sentences and recall or imagine feelings evoked by each described situation. After each situation, we asked participants to indicate on 10 point Likert-type scales the degree of emotional intensity of the imagined scenario (where 1 was completely neutral and 10 was completely emotional). In the automatic emotion elicitation condition, participants rated the emotional intensity as 5.44 (*SD* = 2.5) after negative sentences and 5.96 (*SD* = 2.07) after positive sentences. In reflective emotion elicitation condition, participants rated the emotional intensity as 7.35 (*SD* = 1.73) after negative sentences and 6.55 (*SD* = 1.89) after positive sentences. After neutral sentences, participants rated the emotional intensity as 2.85 (*SD* = 2.41). A repeated measures ANOVA was conducted to investigate differences between control and experimental conditions. We found statistically significant differences for both automatic (F(1, 79) = 96.86, p = .001, η^2 = .55) and reflective (F(1, 79) = 201.954, p = .001, η^2 = .72) emotion conditions. What is more, participants rated their imagined scenarios as more emotional in reflective (*M* = 6.95, *SD* = 1.43) than automatic (*M* = 5.7, *SD* = 1.86) emotion conditions: F(1, 79) = 35.912, p = .001, η^2 = .31.

We used a computerized version of the Antisaccade Task, similar to the original test by Hallet (1978) and similar to methods used by other authors (e.g. Katzir, Eyal, Meiran & Kessler, 2010; Roberts et al., 1994). All these types of tasks involve inhibition of a prepotent response (i.e., gaze at an interfering distractor; Hallett, 1978; Miyake et al., 2000).

In the version of the task we used (Krejtz, Krejtz & Bielecki, 2008), participants were asked to identify letters presented in random order on the left or on the right side of the screen. At the beginning of each trial, a fixation point (+) was presented in the middle of the screen the screen for 250 ms. Each letter was preceded by a distractor: a red spot with a 5 % screen-width diameter, to the right or left of the fixation point at a screen-width distance of 30 or 40 % (stimulus onset asynchrony [SOA]: 20 ms). A target stimulus (one of three letters: b, d, or p) appeared for 80 ms before being replaced (mask procedure) by an X sign. The distractor did not disappear when the target and mask appeared.

Participants answered the question: "Which letter was displayed: p, b or d?". After each decision, before the next trial, a white screen appeared for a variable amount of time (between 500 ms and 1000 ms with increments of 50 ms). The difficulty of the task was increased by the short presentation of the target stimulus (80 ms). To make the task easier, on both sides of the fixation point we put 2 "attention boxes" (white squares in which target letter or distractor my appear) on the screen.

Procedure

Students were invited to participate in a study on perception, attention and imagination. All materials were exposed on 17-inch Sony computer monitors during individual sessions. First, participants practiced performing the Antisaccade Task for 10 trials. Practicing was done to eliminate the novelty effect. Then, the sets of sentences were exposed in random order (2 (valence of emotion - between subject factor) x 2 (emotional system - within-subjects factor)) - each set was shown before another set of 10 antisaccade trials. Participants were asked to read each set of sentences (neutral, or associated with a given type of emotive events - see Table 1) and to imagine feelings evoked by the described situations. Half of the participants read positive-valence sentences and the other half read negative-valence sentences. Participants were then asked estimate the intensity of negative or positive emotions the sentences elicited. Participants performed 5 x 10 antisaccade trials (besides the 10 during the introductory stage): 10 trials after one set of neutral sentences, 10 trials x 2 - after two sets of sentences related to the automatic emotions, and 10 trials x 2 - after two sets of sentences related to the reflective emotions.

Results

We analyzed data collected from 80 participants. A repeated measures ANOVA repeated measures (2 x 2 Mixed Factorial Design: emotional valence (between-subjects) x emotional system (within-subjects)) was conducted to compare accuracy of letter recognition when accompanied by a salient distractor. We found a main effect of emotional category: significantly lower accuracy for Automatic (M = 0.68, SD = 0.15) than for Reflective (M = 0.74, SD = 0.17) sentences: $F(1, 79) = 24.44$, $p = .001$, $\eta^2 = .251$. We found no significant main effect of valence ($F(1, 79) = .428$; $p > .05$; $\eta^2 = .005$), no simple sign effect, and no significant interaction effects.

Using simple contrast analysis, we found only two significant differences comparing the emotional and the neutral conditions: 1) accuracy for the Neutral condition (M = 0.75, SD = 0.17) was significantly greater than for the Automatic negative condition (M = 0.67, SD = 0.15): $F(1, 39) = 8.229$, $p = .007$, $\eta^2 = .174$); and 2) accuracy for the Neutral condition (M = 0.75, SD = 0.17) was significantly greater than accuracy for the Automatic positive condition (M = 0.69, SD = 0.15), $F(1, 39) = 20.796$, $p = .001$, $\eta^2 = .342$. We found no significant differences between correctness of the Neutral and the Reflective negative (M = 0.73, SD = 0.17) and positive (M = 0.75, SD = 0.17) conditions.

These data are coherent with the hypothesis concerning performance of the Antisaccade Task. Results show that task performance was worse after the exposure to sentences associated with the automatic emotions than after the sentences associated with the reflective emotions and after the neutral sentences. The level of performance was similar for the reflective and the neutral sentences. In line with the hypothesis, the data suggest that the automatic emotions elicitation interfered with task performance whereas the reflective emotions had no such influence – at least the influence was no more significant than the influence of the neutral sentences.

Study 2: The Emotional Stroop Test

The aim of Study 2 was to examine the hypothesis of Study 1, using a different method of the emotions elicitation, and a different task requiring cognitive control: inhibition control. We wanted to make our studies comparable with many other psychological studies using the EST. The EST (McKenna & Sharama, 2004) contains words as labels of different types of emotions. The words are printed in different colors, which participants have to name as quickly as possible. We used words associated with negative and positive emotions classified as automatic or reflective. The hypothesis predicted worse performance of the Stroop task in the case of the automatic emotion elicitation than in the reflective emotion and neutral conditions.

Participants

One hundred individuals (68 females and 32 males) participated in the study. They were students of four different faculties of the University of Warsaw, Poland. Ages ranged from 19 to 27 (M = 20.97). Participation was voluntary. All participants spoke Polish as their mother tongue, had normal or corrected-to-normal vision, and normal color vision.

Materials and Method

Eight sets containing eight words each, related to different negative vs. positive emotions specific to the automatic and reflective system of evaluation were used in Within-Subjects Factorial Design. One set of eight neutral words (control condition) was also used. The words were selected so as to be comparable in their frequency index in Polish and word length was similar. The following examples of words are English translations of the Polish words used.

I. words associated with negative vs. positive automatic emotions (homeostatic and hedonic): *illness, hunger, stench, disgust* vs. *regain, consolation, relax, vacation*;

II. words associated with negative vs, positive reflective emotions (related to the self and axiological standards): *shame*, *guilt, harm, exploit,* vs. *pride, loyalty, help, tolerance.*

III. Examples of neutral words: *figure, notebook, activity, mirror*.

To display the experimental procedure we used 15” notebooks with E-Prime 1.1 software. Each exposed word was 2 cm high and an average of 6 cm wide. Each set of eight words appeared only once in a random selection. We marked selected keys on the computer keyboards with white stickers and printed letters – initials of color names, the Polish equivalents of: R – red, B – blue, Y – yellow, G – Green. Participants sat approximately 60 cm away from the computer screen.

Procedure

Participants invited to the study were informed that it would be a study on color recognition. They had to name colors or indicate color abbreviations for different figures and words in two different sessions.

During the trial session, participants completed four steps of the classic Stroop Test procedure: (1) they had to confirm the names of colors (red, green, yellow, blue) printed in black letters; (2) they then to confirm the names of the colors of squares printed in 4 different colors (red, green, yellow, blue); (3) next, participants had to indicate the letter color of each word (red, green, yellow or blue) and ignore the fact that the color word was not the same as the letter color; (4) finally, participants had to read the names of the color words and ignore the fact that the color word was not the same as the letter color (red, green, yellow or blue).

During the experimental session, participants had to indicate the letter color of the neutral and emotional words, printed in 4 different colors (red, green, yellow, blue) answering the question “What color are the letters of the word?” The words of 4 emotional categories (within-subjects factors 2 (emotional valence) x 2 (emotional system)) and the neutral words were shown in a random order. The order of words among the categories was randomized before the experiment and fixed. The color of the letters used for emotional words was randomized with replacement.

Results

The task appeared easy for participants: accuracy on average was 98% (SD = 1.5%). We eliminated wrong responses and analyzed reaction times only for correct answers. Data (reaction times) were converted to logarithm 10 and an ANOVA with repeated measures (2 x 2 Within-Subjects Factorial Design: emotional valence x emotional system) was used to compare the reaction times for indicating colors of the four categories of emotional words. We found a main effect of emotional category such that reaction time was significantly longer for the Automatic (M = 1133 ms, SD = 385) than for the Reflective (M = 1055 ms, SD = 382) words $F(1, 96) = 21.376$, $p = .001$, $\eta^2 = .182$. We found no significant main RT effect for sign of emotion ($F(1, 96) = .013$; $p > .05$, $\eta^2 = .001$), any simple sign effect, or any significant interaction effects.

Using simple contrast analysis, we found only two significant differences when the effects of the emotional and the neutral words were compared: the RT for the Neutral words (M = 1078 ms, SD = 377) was significantly shorter than the RT for the Automatic negative words (M = 1152 ms, SD = 381), $F(1, 97) = 10.492$, $p = .002$, $\eta^2 = .1$, and the RT for the Automatic positive words (M = 1127 ms, SD = 397), $F(1, 97) = 5.175$, $p = .025$, $\eta^2 = .051$. We found no significant differences between RT for the Neutral and the Reflective negative (M = 1048ms, SD = 365) or positive (M = 1067 ms, SD = 395) words.

The data are consistent with the hypothesis concerning performance of the EST. The results show that reaction time was longer for sets of words that were associated with automatic emotions than for sets of words associated with reflective emotions as well as for neutral words. The reaction times for reflective and neutral words did not differ significantly. As predicted, the data suggest that automatic emotions interfered in task performance whereas reflective emotions had no such influence – at least no more significant than the neutral words did.

Discussion

The two presented studies were conducted to measure the effectiveness of cognitive control in conditions of elicitation of automatic versus reflective emotions. The patterns of data gathered in both experiments were similar. In the case of the Antisaccade Test, accuracy of identification of one of three similar letters (b, d, p) in the presence of the salient distractor was lower in when automatic emotions were elicited than in the neutral condition and the reflective emotions condition. The RT of the letters’ colors was longer in the EST for words connected with automatic emotions than for neutral words or words related to reflective emotions. There was no difference between reflective emotions and neutral conditions. There was no difference between conditions of the elicitation of the negative vs. positive emotions of the same type. These results are consistent with the hypothesis. Data seem to confirm the supposition that automatic emotions interfere with cognitive processes significantly more than do reflective emotions – at least in processes measured by the Antisaccade Task and the EST.

The results from Study 1 are similar to our earlier data (Imbir & Jarymowicz, 2011a). Looking for analogous data in literature, we found only one study on the relationship between elicitation of different types of emotions and the antisaccade effect, presented by Katzir and co-authors (Katzir, Eyal, Meiran & Kessler, 2010). The authors used the antisaccade tasks to measure inhibitory control after the elicitation of two different positive emotions: feelings of *happiness* and *pride*. They found less accurate answers in the antisaccade tasks evoking happiness than pride; the results of the latter condition were similar to the neutral condition. This result suggests that *happiness* decreased the level of performance of the task. In reference to the description of the method the authors used, we would argue that the distinction between these two positive emotions (*happiness* vs. *pride*) is relevant to our distinction between automatic and reflective emotions. If so, the results of those authors' studies and our data are the same, regardless of differences in the applied methods: different versions of the antisaccade tasks, and different techniques of emotions elicitation. Also, the theoretical basis for predictions formulated by Katzir and co-authors and our argumentation seem complementary. The authors refer to the distinction between emotions related to short-term goals (happiness) vs. the long-term goals (pride). This distinction, then, would be in agreement with our theorizing. We describe automatic emotions as reactive and related to short-term states, whereas reflective emotions as related to larger categories of phenomenon, related to the anticipatory motivation and long-term satisfaction (Jarymowicz & Imbir, 2010). Thus, we believe that Katzir and co-authors' conceptualization is consistent with our theory of automatic vs. reflective emotions and their different regulatory functions.

How can the results of Study 2 be compared to the results of numerous studies on the Emotional Stroop effect? The authors often argue that interference is specific for negative emotions (Kuhl & Kazèn, 1999; McKenna & Sharma, 1995, 2004). However, there are data showing the same effect for positive emotions. We formulate a suggestion that the inconsitency of results may be due to the type of emotions used in different studies on the EST effect (Imbir & Jarymowicz, 2011b). If we compare the results for the *automatic negative* emotions with results for the *reflective positive* emotions, we find that the Stroop effect is stronger for negative emotions than for the positive ones. But if we compare data for the *automatic positive* emotion with data for the *reflective negative* emotion, the conclusion has to be the opposite: the Stroop effect could be stronger for positive than for negative emotions. Our conceptualization and data lead to the supposition that the Stroop effect is stronger for automatic (sensory) emotions than for reflective (conceptual) emotions, regardless of the emotions' valance. To verify such a hypothesis, one has to control the type of negative and positive emotions. If this postulate is neglected, comparisons between negative and positive emotions of different types can be misleading. In more general terms, we would accentuate the importance of the evaluative system type and of valence interactions in the different domains of studies on emotions. This seems to be especially important in the domain of neurobiological studies related to the valence hypothesis in relation to the right vs. left hemispheres (e. g. Killgore & Yurgelun-Todd, 2007).

To conclude, it seems that the data from both studies presented above suggest that automatic emotions are diffusive and reflective emotions are not diffusive - in a way that means nonspecific interference. There is no doubt that any type of emotion influences cognitive processes. But "diffusive", in this particular theoretical framework, means involuntary interference (Murphy & Zajonc, 1993; Zajonc, 1980, 2000), which decreases the level of cognitive control and task performance. According to this approach, diffusiveness and immediate influence on the processing of unrelated information is specifically due to the automatic elicitation of primary affects, evoked without mediation of deliberative appraisal.

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