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Origin of Emotion Represented in Word Meaning Influences Complex Visual Search Effectiveness

***Abstract**: This study presents the consequences of incidental affect when performing a letter search in a complex visual field. Participants were exposed to two superficially unrelated tasks in succession. First, they had to read and remember as much as possible from among 135 emotional words chosen to enable manipulation of two affective factors, valence and origin of emotional state, in a 3x3 factorial design with alignment of other variables, such as arousal, concreteness, frequency of appearance and length. The second task was based on a visual search paradigm. Participants viewed a display of six letters and responded if at least one of two target letters was present. Analysis of reaction latencies for correct responses showed that valence of the words read in the first task had no effect on visual search effectiveness. The origin of the affective state elicited by the words in the first task did influence response latencies: latencies were longer when the first task involved reading words eliciting emotions of automatic origin rather than words eliciting emotions of reflective origin. This study provides further evidence that valence effects found in earlier studies could be accounted for by other dimensions, especially origin of emotional state.*

***Keywords**: incidental affect, scope of attention, automatic vs. reflective origins of emotions, emotional words, letter search*

A very early stage of cognition is perception and identification of an object in a visual field. This is the crucial step: filtering the stimulation due to attention deployment. For that reason, visual search should be susceptible to the affective state of an individual, since emotion may be treated as a meta-cognitive programme (cf. Tooby & Cosmides, 1990), helping to understand the situation in the context of goals or expectations and executing the cognitive system actions. There have been several attempts to describe the relationship between emotion and cognition (Bower, 1981; Clore & Huntsinger, 2007; Forgas, 1995; Xenakis, Arnellos, & Darzentas, 2012; Yiend, 2010), but the issue of how emotions affect cognition remains open (Imbir, 2016a). The main aim of this research was to find the link between incidental affect, caused by contact with emotionally-charged stimuli that are unrelated to the main task, and the effectiveness of a search for certain objects in a complex visual field.

Emotional States and their Outcomes for Perception

The valence of an emotional state is its most easily understood dimension, describing the affective reactions of individuals (Kagan, 2007); therefore, valence was the first choice to research the impact of emotions on cognition, including the early stages of information processing, concerning the detection of objects in a visual field (Imbir, 2013). The valence dimension was shown to shape perceptions of environmental stimuli and influence the focus (global vs. local) of attention (e.g., Huntsinger, Clore, & Bar-Anan, 2010; Phaf, 2015). Attentional focus appears to be broadened by positive affect and constricted by negative affect (cf. Huntsinger, 2013). Fredrickson and Branigan (2005) showed that the scope of visual attention is influenced by current affective state, such that a positive emotional state promotes global perception. Personality traits such as anxiety (Derryberry & Reed, 1998) also influence the way we perceive a visual field.

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Anxious individuals were found to focus on local stimulus features more rapidly and current anxiety (state anxiety) is thought to enhance this effect. Some data suggest that positive affect can increase the flexibility with which individuals switch between global and local attentional focus (cf. Baumann & Kuhl, 2005). Scope of attention is important in visual search, because it determines ease of processing and the number of elements that can be attended to at a given moment in time (Kolańczyk, 2011).

Visual search is a broad category of tasks in which a target object appears at an unpredictable location surrounded by many distracter objects (Cave, 2014; Schneider & Shiffrin, 1977). Facial emotion was shown to influence the effectiveness of visual search; individuals were more successful when searching for hostile faces rather than peaceful faces among a set of neutral face distracters (Gerritsen, Frischen, Blake, Smilek, & Eastwood, 2008). The facial expressions of emotions themselves are a source of incidental affect and therefore should influence the current core affect state (Russell, 2003). Another study involving visual search for odd objects in 3 x 3 search arrays showed that biologically threatening stimuli such as snakes or spiders are detected more quickly (shorter response latencies), but also influence the first heart rate interval after stimulus onset (Flykt, 2005). Heart rate and other physiological measures are thought to be sensitive to changes in affective state (Russell, 2003). In both the above-mentioned experiments, the emotional information was included in the visual scene to be searched. Emotional stimuli (faces, threatening objects etc.) capture attention, thus triggering processing and for that reason reaction latencies for probes involving them were observed to be shorter. Some other studies have shown that an organism's general physiological state (e.g., during acute exercise) and its aerobic fitness (Bullock & Giesbrecht, 2014) can be treated as models for the activational dimension of arousal (Russell, 2003) and may also influence the efficacy of visual search.

Recent research on the relationship between emotion and cognition suggests that valence may not be the only feature of emotions which influences cognition. Specificity of emotional state (sadness vs. anger) was found to shape perceptions of probability (DeSteno, Petty, Wegener, & Rucker, 2000), and cognitive control (as measured by an anti-saccade task) appeared to be influenced by the type of complexity of imagined or recalled emotions (happiness vs. pride) (Katzir, Eyal, Meiran, & Kessler, 2010). These effects suggest that it is worth trying to understand the mechanisms underlying the complex pattern of emotional states that individuals experience in everyday situations. The duality of mind approach (cf. Gawronski & Creighton, 2013 for a review) offers one perspective on the mechanisms of the mind. Dual mind theories distinguish automatic and controlled processing in the domains of cognition (Kahneman, 2011), social cognition (Gawronski & Creighton, 2013) and even personality (Epstein, 2003).

Duality of Emotions

A model of the relationship between cognition and emotion based on dual mind theory was recently proposed (Imbir, 2016a). Specifically, the model was based on the duality of emotion model (Jarymowicz & Imbir, 2015) which distinguishes between two types of emotional processes based on how they are elicited, i.e., whether they are automatic or reflective in origin. This distinction is related to the dual-mind approach and offers a way of distinguishing between and describing the different types of emotions which appear as a result of experiential or rational mental processing (Epstein, 2003). Emotions of automatic origin are not dependent on language for their expression, but are represented in language as labels of individual states, like pain or threat (Imbir, 2015). They are based on automatic appraisals of a situation in terms of fixed criteria relating to biological value (Damasio, 2010) which result in anything which contributes to biological fitness being evaluated in mind positively whilst anything which threatens biological wellbeing is evaluated in mind negatively. Emotional states of automatic origin appear effortless (Kahneman, 2003, 2011) when one is faced with biologically significant stimuli, such as the angry face of another individual. This means that emotional states of automatic origin are thought to derive from the experiential mind (Epstein, 2003) and often are treated as the primary component of human emotional experience because they are easy to evoke and their outcomes are easy to identify (Jarymowicz & Imbir, 2015).

Emotions of reflective origin appear to be related to emotional states (Lewis, 1995; Weiner, 2005) or feelings (Damasio, 2010; Rolls, 2000) of which the individual is aware. The mechanism by which they are elicited is effortful because it depends on several cognitive operations: (1) creation of a representation of current state; (2) creation of a representation of an ideal state based on certain criteria; (3) drawing conclusions based on comparisons of the two. These processes are reflective in nature (Jarymowicz & Imbir, 2015), based on propositional mechanisms (Strack & Deutch, 2004, 2014) and based on evaluation of the current situation through reference to certain standards (Reykowski, 1989). Evaluative standards are verbal descriptions of the ideal or desirable state of affairs, thus they allow evaluation of particular situations in a way that exhibits variation among different individuals. Emotional states of reflective origin are specific to the individual concerned; in other words two different individuals might interpret the same situation in different ways, using their different personal standards. Like many other types of reflective processing, reflective emotional states are supposed to be part of the rational mind (Epstein, 2003) and to promote systematic thinking (Kahneman, 2011) as a result of the specific activation of knowledge and mechanisms entailed in such processing (Imbir, 2016a).

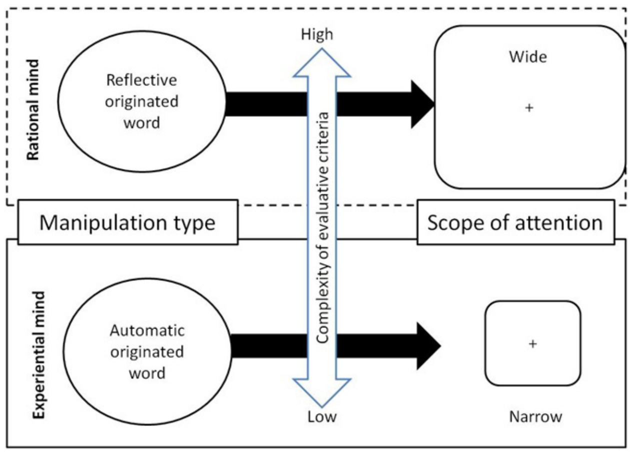
To measure the perceived origins of affective reactions to stimuli, the origin scale was operationalised (Imbir, 2015) with the use of a Self-Assessment Manikin (SAM) technique analogous to that developed to measure valence (cf. Lang, 1980). The SAM scale was developed to overcome the methodological difficulties of measuring reflective emotional states, which arise because they are the most flexible and cognitively-based form of emotion. The inter-individual diversity in reflective emotions is due to the fact that they are derived from appraisals based on subjective evaluation criteria (Reykowski, 1989). SAMs can be used to measure subjective aspects of affective reactions to stimuli. The SAM scale for origin of emotion is based on the metaphorical distinction between heart and mind (cf. Imbir, 2015; 2016b) which captures the relative contributions of automatic-originated (experiential mind and heart metaphor) and reflective-originated (rational mind and mind metaphor) processes underlying emotion formation. It is worth highlighting that although Epstein's (2003) idea of Experiential vs. Rational mind was adopted in order to create the original scale, the assumption was that not only experiential, but also the rational system are able to govern emotional reactions (Jarymowicz & Imbir, 2015). This was controlled with the use of valence measures (stimuli perceived as mind related, of negative and positive valence, were expected to appear in a dataset and were treated as emotional).The origin of emotion SAM scale appears to be a stable and reliable way of assessing subjective perceptions of the origin of affective reactions to verbal stimuli (Imbir, 2015; 2016b). Reflective originated stimuli appeared to be diversed in valence (negative, neutral, and positive stimuli were respectively present in a dataset (Imbir, 2016b)). The complexity of the underlying mechanisms of experienced emotional states, defined in terms of their origin (automatic vs reflective), appeared to be distinct from other purely cognitive measures of complexity called concreteness of stimuli (Imbir, 2016b).

Origin of Emotional State and Complex Visual Search (CVS): Theoretical Predictions

Origin of emotional state appeared to be one factor modulating the scope of attention (Imbir, 2013). An early study used exposure to sets of words and sentences, selected in accordance with the automatic and reflective origins definition criteria by a panel of trained judges, to manipulate the valence and origin of the affective state experienced by individuals. Scope of attention was narrower in individuals who viewed words designed to elicit automatic originated emotional states than in those who viewed words designed to elicit reflective originated emotional states. The task in this study was to respond to dots appearing in the visual field close to or distant from a fixation point. Response latencies for stimuli distant from the fixation point were shorter after priming with stimuli of reflective origin than after priming with stimuli of automatic origin. This result suggests that the origin of an affective state influences scope of attention (Imbir, 2013) and thus provokes changes in the intensity of attention (Kolańczyk, 2011). Intensification of attention is supposed to manifest as a narrowing of the visual field; the opposite effect, referred to as extensification of attention, is supposed to manifest as a broadening of cognitive scope. A broad attentional scope allows an individual to inspect a large number of items at once, or to switch attention from one object to another (Kolańczyk, 2011) and should result in more effective searching of complex visual fields. The changes described above may be referred to the flexibility of attention concept, demonstrated in several studies (e.g., Cave & Zimmerman, 1997; LaBerge, 1983) using tasks involving stimuli of different sizes (small and large) presented in blocks. In the small conditions (one letter, c.f. LaBerge, 1983) the attention was sharply focused on the central location (compared with another four possible peripheral locations) and stimuli appearing in peripheral locations were found to generate slower response latencies. In the case of large conditions (five-letter words) attention was spread more evenly across the five locations, as shown by the fact that response latencies for the various locations were similar. So-called attentional zoom effect (Cave, 2014) may also be treated as an instance in which differences in visual search effectiveness after affective stimuli presentation are to be expected, but it also indicates that stimuli size matters, and thus must be controlled in experiments.

The relationship between attentional scope and cognition can also be observed in domains other than perception. Some studies suggest that scope of attention is linked to the way in which information is processed. A manipulation designed to promote broad attention appeared to increase participants' creativity, measured in terms of the number of original suggested uses for a brick and the generation of more unusual category exemplars (Friedman, Fishbach, Förster, & Werth, 2003). Information distributed in peripheral areas of the visual field resulted in a broad treatment of categories. This suggests that perceptual features of visual information may influence conceptual processing. Taking this into account, it is conceivable to expect that the relation between conceptual complexity and perceptual features of visual information may lead in the opposite direction. Multidimensional criteria of reflective evaluation should prime the more broadly distributed attention and thus influence the visual information search in a complex visual field. Figure 1 presents the theoretical model described by Imbir (2013), which was tested in this study.

Figure 1. Proposed model of associations between the origin of affective state and scope of visual attention. The relationship is mediated by evaluation criteria which are specific to a particular mental system and vary in complexity



Attention influences not only the detection of stimuli, but also the resolution of the visual field, even without eye movements. In visual search tasks, attention allocation was found to produce a greater improvement in detection of peripheral stimuli than of stimuli in the central visual field (Carrasco & Yeshurun, 1998; Morgan, Ward, & Castet, 1998) because it resulted in elimination of the difference in resolution between the fovea and the periphery (Carasco, 2014). These findings were obtained in tasks involving cueing of attention without eye movements, however the extensive attention provoked by stimuli which elicit reflective originated emotional states should have a similar outcome in the context of visual search tasks, i.e., it should improve early visual field inspection and cause gaze to be more correctly directed towards the target letter, thus improving the speed of the visual search.

Aim and Hypothesis

We know a lot about the various factors influencing visual search. What is less known is whether a primary task that involves incidental coding of affective information impacts visual search. The aim of this study was to investigate whether performance on a task involving search of a complex visual field depends on the incidental affect elicited by reading affectively-charged words. It was predicted, based on previous research in which origin of emotional state was used to modulate attentional scope (Imbir, 2013), that stimuli eliciting automatic originated affective responses would result in a narrowing of cognitive scope and thus reduce the efficacy of visual search; in contrast, exposure to stimuli which elicit reflective originated affective reactions were predicted to broaden attentional scope and thus increase the efficacy of visual search (Cave, 2014; LaBerge, 1983). Valence of affective state was not expected to influence visual search performance. This prediction was given further credibility by research showing that cognitive scope (Imbir, 2013) and cognitive control (Imbir & Jarymowicz, 2013) were influenced by the origin of emotions but not by their valence. In these studies, correct response latency was used as an indicator of visual search efficacy.

Method

Participants

Sixty students (30 women and 30 men) at various colleges and universities in Warsaw (balanced with respect to subject of study: social sciences and humanities, natural sciences, engineering or medical sciences) accepted the invitation to take part in a perception study. They were aged from 19 to 29 years old ($M = 22.05$, $SD = 2.03$), had normal or corrected-to-normal vision and were native speakers of Polish. Participation was voluntary and rewarded with low-value gift cards. The sample size was set at 60 and data collection was automatically terminated when the last participant finished the procedure.

Materials

Linguistic materials

A set of 135 words was chosen from a database of 4900 stimuli with known affective properties (Imbir, 2015, 2016b) to fulfil the requirements of a 3 (valence: negative, neutral and positive) x 3 (origin of emotional state: automatic, control and reflective) factorial design. The criteria for the various valence and origin levels were as follows. Level 1: score at least 1 *SD* below mean (Negative or automatic originated); level 2: score within 0.5 *SD* of the mean (Neutral or Control group); level 3: score at least 1 *SD* above the mean (Positive or reflective originated). Stimuli were also matched with respect to other potentially important variables – arousal, concreteness, frequency of appearance in language (Kazojć, 2011) and length of stimulus – within each level of both variables. All selected words had scores within 0.5 *SD* of the mean for arousal and concreteness. Earlier research has demonstrated that such stimuli are an effective method of eliciting affective states and they influence, for example, the electrophysiological correlates of involuntary word processing in a lexical decision task (Imbir, Spustek, & Żygierewicz, 2016). A full list of stimuli and their affective properties is given in Appendix 1.

Separate ANOVAs for the origin and valence dimensions were used to ensure that the sets of stimuli were consistent with the 3 (valence levels) x 3 (origin levels) design. Word frequency estimates were based on occurrence in a database of online Polish texts (Kazojć, 2011) and represent the number of times each word appears in the database. The distribution of frequencies in this database is positively skewed so word frequency data were natural logarithm (LN)-transformed to enable the use of parametric statistics.

Valence ratings differed between valence levels, $F(2,126) = 612.84$, $p < .001$, $\eta^2 = 0.91$, but not origin levels, $F(2,126) = 1.81$, $p = .17$, $\eta^2 = 0.03$ and there was no interaction between valence and origin levels, $F(4,126) = 2.16$, $p = .08$, $\eta^2 = 0.06$. The origin ratings of words did not differ between valence levels, $F(2,126) = 1.47$, $p = .23$, $\eta^2 = 0.02$, but they did differ between origin levels, $F(2,126) = 254.08$, $p < .001$, $\eta^2 = 0.8$; there was no interaction between valence and origin levels with respect to origin rating, $F(4,126) = 0.49$, $p = .74$, $\eta^2 = 0.016$. Arousal ratings were similar for all valence levels, $F(2,126) = 2.00$, $p = .14$, $\eta^2 = 0.03$, and all origin levels: $F(2,126) = 1.46$, $p = .24$, $\eta^2 = 0.02$, and there was no interaction between valence and origin levels with respect to arousal ratings, $F(4,126) = 0.52$, $p = .72$, $\eta^2 = 0.016$. Concreteness ratings were also similar for all valence levels, $F(2,126) = 1.3$, $p = .28$, $\eta^2 = 0.02$, and all origin levels, $F(2,126) = 0.48$, $p = .62$, $\eta^2 = 0.01$, and there was no interaction between valence and origin levels, $F(4,126) = 0.1$, $p = .98$, $\eta^2 = 0.003$. Length of stimulus was similar in all valence levels, $F(2,126) = 0.78$, $p = .46$, $\eta^2 = 0.01$, and all origin levels, $F(2,126) = 1.84$, $p = .16$, $\eta^2 = 0.03$, and there was no interaction between valence and origin groups of levels: $F(4,126) = 0.32$, $p = .86$, $\eta^2 = 0.01$. Finally, LN-transformed frequency of appearance in Polish was also similar for stimuli across all valence levels, $F(2,126) = 2.11$, $p = .13$, $\eta^2 = 0.03$, and all origin levels, $F(2,126) = 0.85$, $p = .43$, $\eta^2 = 0.01$, and there was once again

Table 1. Descriptive statistics (*M*, *SD*) for groups of words used in factorial manipulation

	M	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	Origin Category	*M*	*(SD)*
Valence	3.50	0.36	5.02	0.56	6.71	0.35	Automatic	5.07	1.39
Origin	4.45	0.53	4.58	0.37	4.33	0.70		4.45	0.55
arousal	4.37	0.49	4.15	0.55	4.28	0.80		4.27	0.62
concreteness	4.31	1.15	3.95	0.74	4.48	1.20		4.24	1.05
NoL	7.20	2.65	7.47	1.96	7.40	2.41		7.36	2.31
Ln_freq	5.21	1.91	5.65	2.03	5.73	2.28		5.53	2.04
Valence	3.37	0.36	5.20	0.53	6.38	0.32	Control (0)	4.99	1.32
Origin	5.41	0.31	5.52	0.31	5.36	0.35		5.43	0.32
arousal	4.15	0.23	4.12	0.65	4.04	0.51		4.11	0.49
concreteness	4.05	1.12	3.91	1.33	4.17	0.74		4.04	1.07
NoL	6.47	2.03	6.13	2.17	6.93	2.02		6.51	2.05
Ln_freq	5.48	2.28	5.73	1.28	6.61	2.02		5.94	1.93
Valence	3.66	0.35	5.30	0.39	6.49	0.40	Reflective	5.15	1.23
Origin	6.46	0.30	6.63	0.41	6.63	0.56		6.57	0.43
arousal	4.32	0.49	3.93	0.47	4.03	0.36		4.10	0.46
concreteness	4.17	1.13	4.09	1.17	4.41	1.07		4.22	1.11
NoL	7.00	1.65	6.27	1.62	7.20	2.27		6.82	1.87
Ln_freq	5.42	1.37	6.53	1.79	6.01	1.22		5.99	1.52
Valence category	**Negative**		**Neutral**		**Positive**			**Total**	
Valence	3.51	0.37	5.17	0.50	6.53	0.38	Total	5.07	1.31
Origin	5.44	0.92	5.58	0.92	5.44	1.09		5.48	0.97
arousal	4.28	0.42	4.07	0.56	4.12	0.58		4.16	0.53
concreteness	4.18	1.11	3.98	1.08	4.35	1.01		4.17	1.07
NoL	6.89	2.12	6.62	1.98	7.18	2.20		6.90	2.10
Ln_freq	5.37	1.85	5.97	1.73	6.12	1.89		5.82	1.84

no interaction found between valence and origin levels, $F(4,126) = .6$, $p = .66$, $\eta^2 = 0.02$. These results show that the intended manipulations, valence and origin, were realised successfully and that the selection of stimuli controlled for potential effects of variance in other important variables. Any observed effects could thus be confidently attributed to differences in valence and origin. Table 1 presents the mean (*M*) and standard deviations (*SD*) for the ratings of stimuli in all nine conditions.

Complex Visual Search (CVS) Task

CVS is a task introduced by Schneider and Shiffrin (1977) involving visual inspection of different objects in order to detect odd features in some of them (Kovach & Adolphs, 2015). There are many different types of CVS tasks (Cave, 2014), but in this experiment participants were required to search for a target letter among a set of six-letter stimuli displayed around a fixation point (see Figure 2) (Kovach & Adolphs, 2015). This modification allowed us to assess the effect of changes in cognitive scope for a visual field (Imbir, 2013). The selection of letters was intended to maximise diversity of shape (e.g., A, B, E, F, G, H, K, L, M, N, T, W, X, Y, Z). Such defined diversity includes several similar perceptual features (vertical, horizontal and oblique lines), thus provoking visual competition (Eriksen & Eriksen, 1974) and making the task more difficult. Letters consisting only of curves (e.g., C, O, S) were excluded because this distinctive characteristic might have elicited preferential processing, thus influencing the visual search and making the task easier. The task was to determine whether or not the letter display contained one of the target letters (N or X). Letters were presented around the fixation point at a distance of 25% of the screen diagonal from the central fixation point (see Figure 2). In each trial, six different letters were placed randomly at the six fixed locations to give a circle of letters (Lavie, Lin, Zokaei, & Thoma, 2009) which constituted the CVS probe screen. In half the trials the display contained one of the target letters and in the other half it did not. This task is quite easy and so performance is indexed by latency prior to making a correct response. Faster responses indicate more effective visual search.

Apparatus

The whole experiment was controlled by E-Prime 2.0 software, both presentation of stimuli and recording of response types and response latencies. The procedure was run on standard laptop computer with a 15-inch monitor.

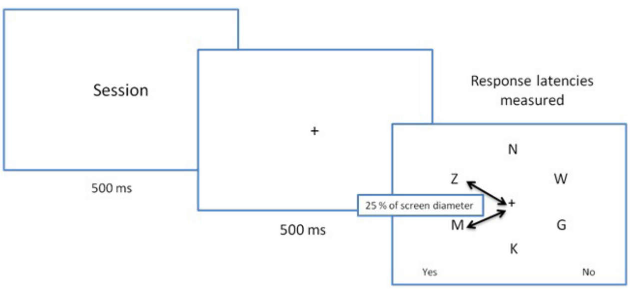
Design

A within-subject design was employed. Participants were presented with words differing in valence (3 levels: Negative, Neutral and Positive) and origin (Automatic, Control and Reflective). Fifteen words representing each of the nine conditions (total number of stimuli was 135) were displayed in random order. Each word appeared only once during the procedure.

Procedure

Participants were invited into the laboratory and informed that they would be taking part in a study of visual search effectiveness and that both the accuracy and speed of their responses were important. They were also told that memory and memory load were a second point of interest and that the next task would be to recall as many words as possible that they would see briefly (for 0.5s) during the first task. Participants were then seated in front of the computer screen and the experiment started. After completing five practice trials of the CVS, they were exposed to 135 experimental trials. Each trial consisted of a 500ms presentation of the stimulus word followed by a 500ms fixation interval during which participants were expected to try to commit the word they had just seen to memory. Following the disappearance of the fixation cross a CVS probe was presented; the display consisted of a random selection of letters appearing in randomly chosen positions. The procedure for a single trial is presented in Figure 2.

Figure 2. Single trial of a procedure in which a complex visual search trial is preceded by exposure to words designed to induce incidental affect of automatic or reflective origin



The last part of the experimental procedure was a recall test involving a list of words presented to participants in alphabetic order. Participants had to decide for each whether it had been displayed earlier or not. Half of the stimuli had actually been used in the experiment while another half were new to participants. This test was provided only to maintain a cover story about the experimental aim. After completing the experimental procedures participants were asked for their impressions of the experiment and the apparent aim of the study. None of the participants guessed that the words presented to them (in particular their affective quality) were supposed to influence performance on the subsequent task and so data from all participants were included in the analysis.

Results

Data Analysis Strategy

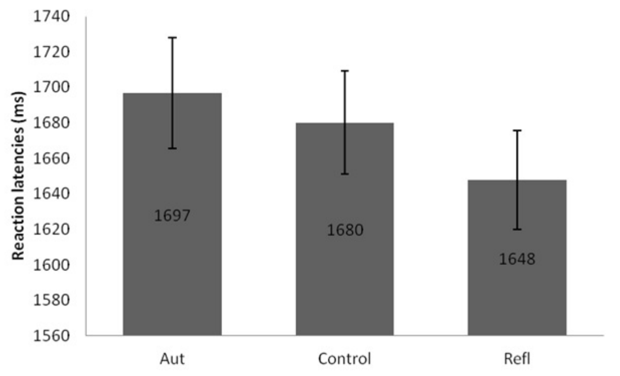
Only correct responses were analysed; this meant that 334 trials (4.1%) for which an incorrect response was given were excluded. Trials with an outlying response latency, i.e., trials on which the response latency was > 350ms ($N = 1$) or more than 3 *SD*s from the mean ($M = 1803$ms, $SD = 1500$ms; $N = 134$ trials) were also excluded. In total 469 out of 8100 trials (5.8%) performed by 60 participants were excluded. Then the response latencies were subjected to an LN transformation; this is a standard procedure for dealing with the positive skew of reaction time data (Heathcote, Popiel, & Mewhort, 1991) so that parametric statistics can be used. After this stage all data (both raw response latencies and LN-transformed response latencies) were aggregated across participants and conditions.

A 3 (emotional valence) x 3 (origin of emotional state) repeated measures ANOVA with LN-transformed CVS response latency as the dependent variable was used to evaluate the data. Although LN-transformed latencies were used in the analyses, the figures show raw response latencies for ease of interpretation.

Response Latencies

There was no main effect of valence level on CVS response latency, $F(2,58) = 1.93$, $p = .16$, $\eta^2 = 0.06$; however there was a main effect of origin of emotional state, $F(2,58) = 3.45$, $p = .038$, $\eta^2 = 0.11$. Simple contrast analysis with the Bonferroni correction for multiple comparisons showed that mean response latencies were different for trials following words eliciting automatic originated emotional states (LN-transformed data: $M = 7.32$, $SEM = .03$) and trials following words eliciting reflective originated emotional states ($M = 7.29$, $SEM = .03$): $F(1,59) = 5.95$, $p = .05$, $\eta^2 = 0.09$. There appeared to be no differences between trials following words eliciting automatic originated emotional states and those following control words, $F(1,59) = .28$, $p = .9$, $\eta^2 = 0.005$; nor between trials following control words or words eliciting reflective originated emotional states, $F(1,59) = 2.99$, $p = .25$, $\eta^2 = 0.05$. The pattern of raw response latencies is shown in Figure 3. There was no interaction between the valence and origin of emotion elicited by words with respect to latency on a subsequent CVS trial, $F(4,56) = .66$, $p = .6$, $\eta^2 = 0.05$.

Figure 3. Figure 3. The pattern of correct response latencies on the complex visual search task. Error bars represents SEM.



Discussion

This study demonstrates how reading and remembering emotional words influences the efficiency with which a complex visual search is performed. The results indicate that the origin of the emotion represented in emotional reactions to the word, but not its valence, is the important factor in determining how the incidental affect influences cognition. The affective stimuli used in this study were carefully selected and their affective properties were checked in advance (Imbir, 2015, 2016b). Response latencies on a CVS task were shorter when the CVS trial was preceded by reflective originated stimuli rather than automatic originated ones. The valence of the word preceding the CVS trial did not affect visual search latency. This suggests that origin of emotion is the most important emotional factor in determining the allocation of attention across a visual field, and that when experiments control for variance in origin of emotion what appear to be valence effects can disappear. It is important to note that the origin effects observed with lack of valence effects (described above) were also observed in another paradigm (Imbir, 2013) and evoked by stimuli presented as manipulation chosen in a different way (definition compliance); it therefore warrants further consideration.

Incidental Affect and Attentional Scope

Incidental affect approach (cf. Ferguson, Bargh, & Nayak, 2005) searches for consequences of task-unrelated affect for the execution of this task. This study can be interpreted as eliciting incidental affect, because one would expect the reading and remembering of the affective words to have only a subtle influence on participants' affective state immediately afterwards (Russell, 2003). Furthermore, affective charge was processed in an implicit way, because explicit task was focused on remembering the content of words, not evaluating them in an emotional manner (i.e., performing valence categorisation or another explicitly emotional task). One would expect the emotional change to be difficult to detect and perhaps not even recognisable at a subjective level. The design used allowed the effect of the manipulations to be enhanced by repeated exposure to each level of both manipulated variables (45 trials per level). None of the participants suspected the real purpose of the experiment, and so one may assume that the results represented the consequences of incidental affect. It is worth highlighting that such a large number of words to remember and trials to accomplish may cause a cognitive overload, resulting in a general simplification of processing, namely more automatic-like than controlled-like. This effect was distributed randomly across all conditions, but still it might have influenced the results obtained.

Several studies have shown that affective state influences the way in which visual information is processed (Baumann & Kuhl, 2005; Fredrickson & Branigan, 2005), especially when valence was considered. For example, moderate intensity of positive valence is thought to activate the extension memory (Baumann & Kuhl, 2005), a high-level intuitive system that can be distinguished from a low-level intuitive system (like experiential mind (Epstein, 2003)). Extension memory gives an individual an overview of extended semantic fields (Rotenberg, 1993) as well as extended self representations (Baumann & Kuhl, 2005). The reason why valence is the most commonly investigated aspect of affect is simple: it is one of the most intuitively understandable aspects of emotional reaction (Kagan, 2007). There is, nevertheless, a need for research into the underlying mechanisms of emotion formation which are not accessible by introspection (Russell, 2003). Origin of emotional state is a dimension that may be useful in explaining the complexity of different emotional states (Jarymowicz & Imbir, 2015), but it is not graspable intuitively. One would expect such complexity, distinct from purely cognitively based concreteness of stimuli differences (Imbir et al., 2016), to influence information processing and hence perceptions of the world.

Based on earlier results (Imbir, 2013), it was predicted in the current study that stimuli eliciting reflective originated emotions would broaden the scope of attention, whereas those eliciting automatic originated emotions would concentrate attention on a smaller area immediately surrounding a fixation point. The results appear to confirm that the proposed model can be applied to visual search tasks. Visual searching was faster following presentation of words eliciting reflective originated emotional responses than of those eliciting automatic originated emotional responses. Stimuli which elicit reflective originated emotions engage more complex, multidimensional evaluation criteria (Imbir, 2013) and hence exposure to such stimuli broadens the scope of attention. This represents the inverse of the relationship found where scope of attention influences thinking in more broad, complex and creative ways (Friedman et al., 2003), triggering the more complex criteria of evaluation associated with stimuli which widen the scope of attention (Imbir, 2013) and visual search. Still, the concrete differences in stimuli used were aligned, and thus results are clearly related to origin differences.

Another useful concept in interpretation of results is so-called extensive attention, defined by Kolańczyk (2011) as a state in which attention is broadly distributed and encompasses more objects, but at the expense of depth of processing. In extensive attention, depth of processing is defined in terms of focus on the perceptual features of stimuli rather than on their meaning. Such a definition meets the predictions regarding letter search, i.e., that perceptual futures of shapes are more important than letter meaning. Intensive attention, on the other hand, is a state in which attention is focused on the central visual field and information from there is processed carefully, whilst peripheral stimuli are neglected (Kolańczyk, 2011). In other words, in a state of intensive attention it is harder to detect stimuli remote from the focal point of attention (Imbir, 2013) and harder to process information about such stimuli. The results of this are also consistent with the concept of 'attentional zoom' (Cave, 2014). The current study showed that the flexibility of attention is susceptible to the incidental affect caused by processing of affectively-charged stimuli. The relative reduction in response latency following presentation of stimuli eliciting reflective originated emotions may be due to a broadening of attention and an increased resolution of the peripheral visual field (Carasco, 2014; Carrasco & Yeshurun, 1998; Morgan et al., 1998). Gaze direction during visual searching was not measured, and it is also possible that higher peripheral resolution made the gaze direction search more efficient, which thus reduced response latencies.

It is worth considering the type of processing evoked by reflective originated words. The extensification effect may be interpreted in terms of extension memory system activation (Baumann & Kuhl, 2005). This implies that reflective words have to evoke parallel processing of evaluation criteria, characteristic of a high-level intuitive system (but still resembling an experiential mind) rather than serial processing, characteristic of controlled processing of a rational mind (Strack & Deutsch, 2014). Such an alternative interpretation is supported by the fact that the paradigm applied may cause cognitive fatigue resulting in a simplification of processing.

Finally, the lack of a valence effect in this study and in an earlier study (Imbir, 2013) requires discussion. It is not surprising, since particular emotions are different from one another, that the same valence of different emotional states can cause opposite effects. For example, Katzir et al. (2010) found that two different positive emotions – namely, happiness (an emotion related to short-term goals, associated with appealing events such as vacations, parties, etc.) and pride (an emotion related to achievement of long-term goals, e.g., success in work or school) – had opposite effects on cognitive control. Analogous results have been reported with respect to negative emotions (DeSteno et al., 2000). These results suggest a very important conclusion. As a result of the neglect of specificity of emotional states in terms of their complexity or the nature of their underlying mechanisms, one may conflate, for example, negative-valenced automatic originated states with positive-valenced reflective originated states, and thus misidentify results caused by origin differences as valence effects. Only in experimental designs in which all relevant variables are carefully controlled can effects be measured reliably. This study provides evidence that origin of emotion can explain the role of incidental affect in visual search. Still they should be interpreted in the context of the paradigm applied and further studies concerning the role of valence and origin are needed.

Conclusion

Visual search performance can be influenced not only by general affective state (Bullock & Giesbrecht, 2014) and emotional information included in target objects (e.g., angry face, spider or snake), but also by the incidental affect evoked by reading and remembering emotionally-charged words beforehand. The broadening of attentional scope produced by priming with words eliciting reflective originated emotions increased the speed of visual search relative to priming with words eliciting automatic originated emotions. The lack of valence effect suggests that, although valence is an easily grasped aspect of affect, origin has more effect on the early stages of visual search. The words presented to participants were carefully selected to avoid confounding the effects of valence and of origin of emotion with those of other factors, such as arousal, concreteness or frequency of appearance in language.

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Appendix 1

Polish word	English translation	Category	valence_cat	origin_cat	val_M	conc_M	arousal_M	Origin_M	dom_M	imag_M	AoA_M	Signif_M	freq	NoL
czkawka	hiccup	ANeg	1	1	4,04	3,18	3,86	4,54	3,60	7,44	7,76	2,86	79	7
szloch	sob	ANeg	1	1	3,04	3,68	4,70	3,58	2,80	6,94	9,50	4,36	735	6
łzy	tears	ANeg	1	1	3,66	2,08	4,54	3,38	3,58	8,26	6,82	4,60	660	3
uszczypnięcie	pinch	ANeg	1	1	4,06	3,44	4,38	4,38	4,62	6,96	7,86	2,96	24	13
pijak	drunk	ANeg	1	1	2,76	2,84	5,40	4,98	2,72	7,58	9,34	3,76	467	5
naiwniak	sucker	ANeg	1	1	3,38	5,40	3,84	4,16	2,64	4,90	9,98	3,74	23	8
słabeusz	weakling	ANeg	1	1	3,18	5,39	3,58	4,98	2,50	5,82	10,06	3,48	32	8
zmęczenie	fatigue	ANeg	1	1	3,28	5,56	3,50	4,90	3,04	6,76	7,68	4,62	2044	9
hałas	noise	ANeg	1	1	3,56	4,18	4,60	4,74	4,98	6,62	7,16	3,62	3199	5
plotka	rumor	ANeg	1	1	3,50	5,04	4,48	4,78	4,22	5,18	9,04	4,12	588	6
grymas	grimace	ANeg	1	1	3,76	4,20	4,52	4,42	4,16	6,88	9,00	3,58	1618	6
gafa	blunder	ANeg	1	1	3,66	5,18	4,58	4,42	3,88	5,36	9,42	3,80	23	4
usidlenie	ensnaring	ANeg	1	1	3,88	5,38	4,52	4,90	4,00	4,72	11,20	3,66	9	9
smarkacz	stripling	ANeg	1	1	3,36	3,46	4,64	4,88	3,64	6,18	8,88	3,98	265	8
zaślepienie	infatuation	ANeg	1	1	3,32	5,64	4,40	3,66	3,33	5,38	10,80	4,22	75	11
procesja	procession	ANeu	2	1	4,76	3,56	3,50	4,88	5,06	7,04	9,06	2,78	293	8
kościół	church	ANeu	2	1	5,24	3,78	3,54	4,46	5,46	8,06	7,32	4,42	3652	7
kuksaniec	nudge	ANeu	2	1	4,53	3,02	4,10	4,55	4,70	6,49	10,38	2,85	13	9
tarot	tarot	ANeu	2	1	4,16	3,92	3,72	4,90	4,60	7,22	11,29	2,66	38	5
loteria	lottery	ANeu	2	1	5,76	3,46	4,10	4,70	4,78	6,70	8,12	3,12	56	7
westchnienie	sigh	ANeu	2	1	5,48	4,44	3,60	4,28	4,42	7,12	10,08	3,82	1336	12
jałmużna	alms	ANeu	2	1	4,36	3,92	4,04	4,84	3,86	6,22	10,96	3,84	44	8
błazen	clown	ANeu	2	1	4,64	3,26	4,28	4,62	4,22	7,50	8,94	2,34	507	6
mrowienie	tingling	ANeu	2	1	4,26	4,39	3,96	4,90	3,88	6,16	10,18	3,24	482	9
pragnienie	desire	ANeu	2	1	5,14	5,80	5,18	3,40	4,78	5,80	9,38	5,54	4066	10
obrzęd	rite	ANeu	2	1	5,04	4,90	3,66	4,76	5,30	5,48	10,82	3,76	220	6
wróżka	fairy	ANeu	2	1	5,60	4,30	4,18	4,68	4,90	7,60	6,64	2,92	338	6

Polish word	English translation	Category	valence_cat	origin_cat	val_M	conc_M	arousal_M	Origin_M	dom_M	imag_M	AoA_M	Signif_M	freq	NoL
młodzież	youth	ANeu	2	1	5,68	3,40	4,66	4,50	5,58	7,00	9,24	3,98	1703	8
łasuch	gourmand	ANeu	2	1	5,74	4,00	4,40	4,72	4,52	6,37	8,84	3,60	9	6
burza	storm	ANeu	2	1	4,86	3,06	5,30	4,54	5,34	7,96	7,40	4,48	3238	5
zakochanie	infatuation	APos	3	1	7,56	7,24	6,50	2,28	5,16	6,60	9,52	6,20	52	10
passa	streak	APos	3	1	6,16	5,78	4,36	4,84	5,92	3,68	11,16	4,26	41	5
toast	toast	APos	3	1	6,36	3,92	4,30	4,60	5,82	7,52	9,54	3,34	689	5
powitanie	welcome	APos	3	1	6,50	4,70	3,90	4,96	5,76	6,46	8,12	4,04	1825	9
zapach	fragrance	APos	3	1	6,80	4,28	3,70	4,66	5,48	5,98	6,74	4,26	9963	6
słodycz	sweetness	APos	3	1	7,02	3,54	4,14	4,44	5,56	7,12	7,46	3,62	477	7
pomoc	help	APos	3	1	6,84	5,06	3,54	4,48	5,58	5,72	6,90	6,30	10180	5
niemowlak	infant	APos	3	1	6,50	2,50	3,70	3,86	3,46	8,08	7,60	4,70	28	9
flirt	flirt	APos	3	1	6,46	5,72	5,52	3,36	6,06	6,88	11,04	4,74	146	5
potomstwo	offspring	APos	3	1	6,62	3,36	3,68	4,60	5,62	6,54	10,32	4,86	504	9
pozdrowienie	greeting	APos	3	1	6,72	5,40	3,58	4,60	5,88	6,02	8,30	4,26	364	12
skarb	treasure	APos	3	1	6,84	3,72	4,20	4,76	7,02	7,46	6,36	4,48	2460	5
walentynka	valentine	APos	3	1	6,42	4,24	4,66	4,26	5,34	7,66	8,20	3,84	2	10
podarunek	gift	APos	3	1	6,78	3,56	4,30	4,44	5,84	6,94	8,32	4,00	373	9
ferie	holiday	APos	3	1	7,10	4,14	4,12	4,82	5,55	6,56	8,44	3,80	123	5
wina	fault	ONeg	1	2	3,46	5,78	4,52	5,18	4,00	4,86	7,40	3,92	9887	4
ciemnota	unacquaintance	ONeg	1	2	3,16	5,41	4,34	5,38	2,98	5,08	10,22	3,80	87	8
truchło	carcass	ONeg	1	2	3,56	2,90	3,98	5,16	3,33	5,50	11,25	3,21	68	7
dół	pit	ONeg	1	2	4,04	3,28	4,02	5,52	3,76	7,12	6,18	3,96	24000	3
ochłap	offal	ONeg	1	2	3,28	3,72	3,80	5,60	3,31	5,81	10,74	2,98	118	6
breja	slush	ONeg	1	2	3,49	3,11	4,10	5,90	3,71	6,33	11,06	3,38	43	5
paszkwil	libel	ONeg	1	2	3,57	5,38	4,51	5,48	4,21	4,47	12,66	2,77	69	8
kuternoga	lame	ONeg	1	2	3,77	2,96	4,13	5,07	3,80	6,07	11,54	3,15	37	9
reumatyzm	rheumatism	ONeg	1	2	2,96	3,96	3,72	5,90	3,46	5,38	12,04	2,98	211	9
biedak	wretch	ONeg	1	2	3,48	3,22	4,16	5,18	2,76	6,68	8,76	3,36	794	6

Polish word	English translation	Category	valence_cat	origin_cat	val_M	conc_M	arousal_M	Origin_M	dom_M	imag_M	AoA_M	Signif_M	freq	NoL
śpiączka	coma	ONeg	1	2	2,44	3,70	4,02	5,36	2,72	6,80	9,62	4,32	53	8
obtarcie	sore	ONeg	1	2	3,46	3,20	4,22	5,06	4,10	7,22	8,20	2,88	7	8
błąd	error	ONeg	1	2	3,38	5,68	4,34	5,46	3,30	5,16	7,28	4,78	5631	4
łachmany	rags	ONeg	1	2	3,26	3,04	4,30	4,98	3,28	6,98	9,74	2,86	387	8
wada	drawback	ONeg	1	2	3,30	5,36	4,12	5,86	3,06	4,88	8,52	4,46	211	4
doping	cheering	ONeu	2	2	5,24	4,46	5,18	5,12	5,48	6,26	11,16	3,30	23	6
transparent	banner	ONeu	2	2	5,28	2,52	3,74	5,62	5,60	7,26	10,96	3,18	132	11
kłębek	hank	ONeu	2	2	5,40	2,68	3,58	5,72	4,34	7,38	7,90	2,46	1093	6
telewizja	television	ONeu	2	2	5,24	3,14	3,54	5,74	5,44	7,92	6,78	3,72	529	9
guru	guru	ONeu	2	2	4,94	5,56	4,00	6,04	6,96	5,66	11,30	3,40	199	4
wódka	vodka	ONeu	2	2	5,60	1,58	5,76	5,10	4,54	8,24	9,90	4,00	568	5
karykatura	caricature	ONeu	2	2	5,56	3,88	4,20	5,69	4,82	7,54	10,28	2,50	131	10
czara	goblet	ONeu	2	2	5,48	2,65	3,68	5,43	5,46	6,53	11,46	2,51	214	5
smok	dragon	ONeu	2	2	5,66	4,18	4,58	5,14	6,78	8,04	6,48	2,80	3438	4
blef	bluff	ONeu	2	2	4,10	5,64	4,28	5,52	5,12	4,58	11,34	3,60	136	4
żargon	jargon	ONeu	2	2	4,94	5,02	3,67	5,65	4,94	4,40	12,48	3,48	174	6
głębia	depth	ONeu	2	2	5,26	5,48	3,74	5,38	5,00	6,64	10,02	4,36	243	6
farsa	farce	ONeu	2	2	3,98	5,54	4,54	5,08	4,25	4,00	12,18	3,31	144	5
grono	bunch	ONeu	2	2	5,60	3,30	3,60	5,70	5,50	6,02	9,90	3,08	574	5
pisarz	writer	ONeu	2	2	5,74	2,98	3,76	5,92	6,04	6,88	8,26	3,96	2412	6
przyjęcie	party	OPos	3	2	6,78	3,88	4,54	4,96	5,58	7,22	7,42	3,80	3452	9
rejs	cruise	OPos	3	2	6,44	3,06	3,64	5,40	5,82	7,14	9,36	2,96	689	4
powiew	waft	OPos	3	2	6,10	3,66	3,50	5,45	5,20	6,52	8,76	3,18	1391	6
promocja	promotion	OPos	3	2	6,70	4,68	4,56	5,68	5,64	6,40	8,16	4,24	61	8
klimat	climate	OPos	3	2	6,06	3,90	3,86	5,86	5,28	5,16	10,06	3,90	824	6
gość	guest	OPos	3	2	6,42	3,28	3,76	5,38	5,44	6,28	6,86	4,36	4380	4
brawa	applause	OPos	3	2	6,68	4,40	4,80	4,76	6,14	6,68	6,52	4,10	1053	5
kreskówka	cartoon	OPos	3	2	6,82	3,04	3,96	5,14	4,90	7,84	6,20	3,76	2	9

Polish word	English translation	Category	valence_cat	origin_cat	val_M	conc_M	arousal_M	Origin_M	dom_M	imag_M	AoA_M	Signif_M	freq	NoL
melodia	melody	OPos	3	2	6,88	4,50	3,46	5,24	5,38	6,00	7,46	3,86	750	7
wydarzenie	event	OPos	3	2	5,86	4,52	4,54	5,90	5,58	5,26	8,28	5,20	1417	10
smak	taste	OPos	3	2	6,32	4,54	3,56	5,04	5,54	5,90	7,64	4,20	2946	4
południe	south	OPos	3	2	6,04	4,24	3,58	5,10	5,00	6,94	7,70	3,48	9135	8
malarstwo	painting	OPos	3	2	6,12	4,38	3,58	5,24	5,30	6,78	8,18	3,50	321	9
wyzwanie	challenge	OPos	3	2	6,24	5,92	4,66	5,34	6,42	5,06	9,42	5,08	1521	8
obrońca	defender	OPos	3	2	6,30	4,49	4,64	5,88	6,70	6,24	8,42	4,46	564	7
egzaminy	exams	RNeg	1	3	3,60	3,84	5,60	7,02	4,86	7,44	9,64	4,88	340	8
ignoracja	ignorance	RNeg	1	3	2,98	6,44	4,68	6,14	4,36	4,32	11,32	4,64	140	9
krata	grating	RNeg	1	3	3,98	1,74	3,60	6,16	4,88	7,66	8,42	3,02	357	5
minus	minus	RNeg	1	3	3,84	4,90	3,52	6,36	3,84	7,36	7,28	3,56	554	5
szpieg	spy	RNeg	1	3	3,92	3,30	4,20	6,72	5,88	6,54	9,08	3,62	637	6
koszty	costs	RNeg	1	3	3,78	3,88	4,08	6,40	4,76	4,74	9,78	3,76	1134	6
podwładny	subordinate	RNeg	1	3	4,12	4,06	4,02	6,28	3,54	5,36	10,68	3,98	189	9
podatek	tax	RNeg	1	3	3,32	3,60	4,22	6,92	4,82	5,22	11,04	3,48	228	7
alimenty	alimony	RNeg	1	3	3,60	3,42	4,48	6,34	4,14	5,24	11,56	3,06	82	8
odsetki	interest	RNeg	1	3	3,78	3,80	4,36	6,56	4,36	5,16	11,43	3,62	58	7
rząd	government	RNeg	1	3	3,80	3,64	4,50	6,50	6,50	6,72	9,44	3,50	5596	4
przemyt	smuggling	RNeg	1	3	3,70	4,00	4,60	6,68	4,94	5,64	10,51	3,96	180	7
recesja	recession	RNeg	1	3	3,63	5,13	4,20	6,65	3,68	3,66	12,66	3,20	25	7
bezrobocie	unemployment	RNeg	1	3	2,92	5,40	4,20	6,06	3,06	4,72	10,98	4,92	122	10
heretyk	heretic	RNeg	1	3	3,94	5,42	4,58	6,10	4,82	5,00	12,68	3,64	45	7
szlachta	nobility	RNeu	2	3	5,46	3,90	4,08	6,22	6,90	7,06	10,46	2,78	811	8
etykieta	label	RNeu	2	3	4,90	3,08	3,52	6,60	5,12	6,30	10,76	3,90	126	8
sułtan	sultan	RNeu	2	3	5,10	3,10	3,46	6,84	6,98	6,84	11,58	2,50	397	6
zadatki	makings	RNeu	2	3	5,32	5,34	3,80	5,98	5,38	3,72	11,48	3,68	94	7
prawo	right	RNeu	2	3	5,84	5,96	3,68	7,60	6,16	5,18	8,76	5,12	19169	5
prasa	press	RNeu	2	3	5,30	2,84	3,50	6,64	5,78	7,44	9,26	3,70	1232	5

Polish word	English translation	Category	valence_cat	origin_cat	val_M	conc_M	arousal_M	Origin_M	dom_M	imag_M	AoA_M	Signif_M	freq	NoL
stawka	bid	RNeu	2	3	5,42	4,02	4,42	6,28	5,86	4,86	10,48	4,10	301	6
raport	report	RNeu	2	3	4,88	2,84	3,56	6,98	5,26	6,16	11,12	4,36	2634	6
wojsko	army	RNeu	2	3	4,94	2,90	4,96	6,62	6,70	7,68	7,76	4,16	2893	6
interes	business	RNeu	2	3	5,86	4,82	4,36	7,10	6,40	5,26	9,22	3,92	3421	7
dyscyplina	discipline	RNeu	2	3	5,46	5,74	3,96	6,44	5,92	4,98	9,54	4,74	384	10
wynik	result	RNeu	2	3	5,52	4,58	4,60	6,70	5,74	5,71	7,60	5,16	1919	5
weto	veto	RNeu	2	3	4,41	5,57	4,02	6,62	6,72	4,69	11,42	3,68	19	4
hodowla	breeding	RNeu	2	3	5,56	2,82	3,62	6,12	5,36	6,82	9,88	2,84	131	7
kurs	course	RNeu	2	3	5,48	3,82	3,48	6,66	5,34	5,66	9,20	3,56	2801	4
miliard	billion	RPos	3	3	7,08	4,18	4,68	7,06	6,78	6,16	9,98	4,34	311	7
tolerancja	tolerance	RPos	3	3	6,62	7,32	3,88	5,32	5,88	4,56	10,90	6,04	139	10
mistrz	master	RPos	3	3	7,22	4,38	4,52	6,24	7,72	6,06	8,66	4,88	4209	6
patent	patent	RPos	3	3	5,92	4,62	3,52	7,59	6,42	4,80	11,80	4,26	221	6
dobytek	property	RPos	3	3	6,48	3,78	3,74	6,76	6,16	5,76	10,66	4,58	552	7
absolwent	graduate	RPos	3	3	6,38	3,44	3,90	6,56	6,20	6,64	11,56	4,38	206	9
uczony	scholar	RPos	3	3	6,26	5,04	3,58	7,44	6,90	5,98	9,78	4,54	1421	6
stypendium	scholarship	RPos	3	3	7,06	3,16	4,12	6,62	6,34	5,90	11,60	5,08	372	10
szczyt	peak	RPos	3	3	6,44	3,28	4,08	6,12	6,62	7,74	9,16	4,52	3533	6
równowaga	balance	RPos	3	3	6,08	5,38	3,56	6,32	5,80	5,82	9,16	5,02	367	9
oszczędności	savings	RPos	3	3	6,68	4,40	3,94	6,94	5,84	5,94	9,36	5,36	737	12
płaca	wages	RPos	3	3	6,16	3,27	4,27	6,82	5,54	5,80	10,60	5,04	63	5
satyra	satire	RPos	3	3	6,04	5,10	4,04	6,16	5,52	5,08	11,92	3,36	171	6
lider	leader	RPos	3	3	6,22	4,06	4,50	6,58	7,58	6,58	9,94	4,68	90	5
zysk	profit	RPos	3	3	6,78	4,76	4,18	6,88	6,76	5,22	10,22	4,98	651	4