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AN ERP STUDY OF INATTENTIONAL BLINDNESS CONDITION

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Abstract

Sometimes we do not notice a salient object while being occupied with some attention-demanding task, a phenomenon known as inattentional blindness (IB). Nowadays the question of the origin of IB is posed in terms of the differentiation between the processes of attention and consciousness. The goal of the present study was to examine the correlates of object-based attention (SN), early visual awareness (VAN), and late-visual awareness (300 ms after the presentation) in the IB condition. Our experiment used a modified version of the method of Koivisto and colleagues (Koivisto, Kainulainen & Revonsuo, 2009). Subjects were presented with two different letter stimuli that could be masked; subjects responded either that they saw or didn't see the target letter (in the attended or unattended field) whenever it appeared. IB was considered as a condition when subjects responded "I do not see" when the unmasked target letter was presented in an unattended field. Our study showed that in a condition of IB the correlate of object-based attention (SN) was detected in the absence of the conscious processing component (P300). This, together with the absence of the lack of verbal reporting in later stages of processing, implies that the process of early stimuli discrimination might take place. Thus the response "I do not see" in the IB condition in our study could be associated with underachieving in the last stage of stimulus processing, which is "access consciousness".

Keywords: inattentional blindness, consciousness, visual awareness negativity, selective negativity.

Sometimes we do not notice a salient object while being occupied with some attention-demanding task, a phenomenon known as inattentional blindness (IB). A number of hypotheses describe possible causes of IB (Cartwright-Finch & Lavie, 2007; Most, Scholl, Clifford, & Simons, 2005) and the most widely accepted one is that of the discoverers of the effect (Mack & Rock, 1998): an extra item stays unnoticed due to the lack of attention paid to it. However, nowadays the question of the origin of IB is posed again in terms of the differentiation between the processes of attention and consciousness.

In this paper attention is referred to as a selective mechanism while con-

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sciousness is considered as contents (thoughts, memories, perceptions) rather than a state (like sleep) which is consistent with most of the articles that are cited in this work (see Cohen, Cavanagh, Chun, & Nakayama, 2012 for example). Consciousness/ awareness and attention could be considered as dissociable processes (Fei-Fei, VanRullen, Koch, & Perona, 2002; Koch & Tsuchiya, 2007; Olivers & Nieuwenhuis, 2006; Van Boxtel, Tsuchiya, & Koch, 2009; Wyart & Tallon-Baudry, 2008) or non-dissociable stages of one cognitive process (Lamme, 2003; Dehaene, Changeux, Naccache, Sackur, & Sergent, 2006). In these terms IB could be described as an effect of interaction between these two processes.

According to C. Koch and N. Tsuchiya (Koch & Tsuchiya, 2007), conscious perception is possible in the absence or near absence of attention. The IB effect is characterized as a lack of awareness in the absence of top-down attention in the authors' classification (Koch & Tsuchiya, 2007, p. 17). Awareness, in spite of a lack of top-down attention modulation, is described as a gist phenomenon – a rapid grasping of the natural scene. The gist is opposite in effect to IB (it results in awareness rather than in unawareness) but it is very similar in an experimental paradigm to IB (a dual-task paradigm includes one attention-demanding task and another task or item that is processed unattended). One could consider these two effects (gist and IB) to be two sides of the same phenomenon. Also, one of the first demonstrations of gist happened to be found during IB research (Mack & Rock, 1998, chap. 7). However, in the case of the near absence of top-down attention processing, any representation of the information would be short-termed and not detailed. Thus, although the gist paradigm is similar to the IB paradigm in certain ways (see Fei-Fei et al., 2002, but also see Cohen, Alvarez, & Nakayama, 2010; Mack & Clarke, 2012 for a critique), there is no appropriate experimental task that could allow the measuring of visual awareness in these phenomena .

Another assumption about the causes of IB was made by Dehaene and Changeux (2005). They claim that IB is the consequence of a neuronal mechanism providing the function of consciousness. The authors adhere to the theory of the global workspace by Baars (Baars, Franklin, & Ramsoy, 2013), which holds that unconscious processing takes place in separate local modules, while conscious processing requires full access to all of them, creating a global workspace. Based on this theory, the authors developed a simplified neuronal model of multiple interconnected thalamo-cortical columns linked by long-range excitatory axons (Dehaene & Changeux, 2005). In this model, the spontaneous activation occurs in the system due to ascending perceptual input. Following this a sudden excitement ("ignition") develops in the system at the level of long-range connections. And, notably, this excited state can prevent the system from receiving any external input. The authors consider this state of neurons with long projections as an endogenous state of consciousness. As it is not possible to pass the information input to the system during an ignited state, it is considered as a cause for not noticing the extra item in IB. That is, IB happens due to the fact that consciousness is busy processing the previously received input. However, the authors do not consider the role of attention in the occurrence of IB in this model.

In 2014 Raffone and colleagues modified the theory of Dehaene and Changeux. This modification allowed for making new predictions about attentional effects; in particular, attentional blink and IB (Raffone, Srinivasan, & van Leeuwen, 2014a). On the basis of neurophysiological data from different research studies, the authors suggest that attentional processes (object location, feature integration, visual selection) and consciousness (information integration, consolidation of memory traces) have identical principles of working and take place in the same thalamo-cortical networks. However, they differ in timing; that is, attentional selection (provided by visual attentional workspace[1]) precedes consciousness (provided by global workspace[2]) in order to open access to it. Notably, if consciousness is busy with processing information, attentional capture is temporarily disabled. Particularly in the case of IB, there is a decoupling between global workspace and visual attentional workspace. Global workspace stores the relevant information and processes it, and for this reason attentional amplification and ignition are impossible, which explains the IB effect. The proposed mechanism explains the experimental finding that IB also occurs with respect to expected stimuli.

The model by Raffone assumes the necessity of attention for awareness, an idea supported by a number of studies demonstrating an increase in the probability of visual awareness in the presence of attention to the object (Carrasco, Ling, & Read, 2004) (even in the case of late visual reactivation when attention is delayed and then cued to the stimulus offset presented at the threshold contrast (Sergent et. al., 2013)). Thus, this model, in accordance with the model developed by Dehaene and colleagues, does not involve the differentiation of the processes of attention and consciousness, in contrast to the model proposed by Koch and colleagues.

However, there are also some disputes as to whether or not processes of consciousness can precede the work of attention. According to Block (2007), information processing begins with "phenomenal consciousness" of the object, which arises earlier than its attentional processing and is characterized by subjective experience without verbal report. The verbal report is associated with the "access consciousness".

[1] "...Visual attentional workspace (VAW) refers to a dynamic thalamo-cortical network for visual processing characterized by a limited (processing) capacity. In the VAW, amplification and ignition processes take place for visual attentional filtering, attentional selection, object identification, object localization, and buffering before consolidation in VWM (visual working memory)" (Raffone, Srinivasan & van Leeuwen, 2014a, p. 7).

[2] "...GW (global workspace) crucially involves areas in lateral (ventral and dorsal) prefrontal, posterior parietal and anterior cingulate cortices. TAC (theory of attention and consciousness proposed by authors), however, originally postulates higher-order representations of executive operations besides object (target) representations in the GW" (Ibid., p. 6).

Lamme (2003) further developed this idea, suggesting that "phenomenal consciousness" begins with the early stages of activation in the visual cortex (through recurrent circuits) and can then proceed to the "access consciousness", which is provided by different mechanisms including attentional selection. In a series of studies (Railo, Koivisto, & Revonsuo, 2011; Koivisto, Revonsuo, & Salminen, 2005; Koivisto, Revonsuo, & Lehtonen, 2006; Koivisto & Revonsuo, 2010 etc.) psychophysiological components associated with early "phenomenal consciousness" (amplitude difference in reaction to masked vs unmasked stimuli around 200 ms after stimulus onset — visual awareness negativity, VAN) and "access consciousness" (late positivity, 300 ms after stimulus onset) were found. Also, in the study by Koivisto and colleagues (Koivisto, Kainulainen, & Revonsuo, 2009) a separate component of object-based attention was identified (amplitude difference in reaction to target vs non-target 200 ms after stimulus onset — selective negativity, SN), which demonstrates that the processing of visual information can occur at a very early "phenomenal consciousness" stage separate from attentional processes. In this model, which separates visual attention and consciousness processes, the IB effect may occur at a very early stage of awareness for other reasons not related to the occupation of consciousness with previous input (Kentridge, Nijboer, & Heywood, 2008). Taking into account all the theories, it can be concluded that there are different assumptions about the origin of IB. Each approach considers the lack of one of the processes as the cause of the effect:

1. The lack of top-down attention in the possible presence of visual awareness (Koch & Tsuchiya, 2007).
2. The lack of attentional amplification and ignition and, as a result, an inability to consciously perceive the extra item in IB (Dehaene et al., 2006; Raffone et al., 2014a).
3. "Phenomenal consciousness" is possible without "access consciousness" (Block, 2007; Lamme, 2003) though the lack of attention prevents the information from becoming available through "access consciousness".

Psychophysiological studies of IB

Despite the fact that IB is considered as a paradigm that could gain understanding of the differences between attentional and consciousness processes (Lavie, Beck, & Konstantinou, 2014; Cohen et al., 2012; Raffone, Srinivasan, & van Leeuwen, 2014b) there has only been a small amount of neuro-scientific research in this field.

The first attempt to study the process of visual awareness with ERP in the IB paradigm was made by Pitts and colleagues (Pitts, Martinez, & Hillyard, 2011). In this experiment, participants responded to changes in the brightness of small disks (dim-disk task) located equidistantly from the center of the screen. Meanwhile, irrelevant white lines presented in the center could be placed randomly or arranged in a pattern which served as an extra item. According to the results, when this pattern was not noticed by participants component Nd1 (in the time window of 200–260 ms after stimulus onset) was detected, associated with an increase of phenomenal consciousness. However, the component associated with the "access consciousness", Nd2, (in the time window of 300–340 ms after stimulus onset) was not found. The researchers interpret the result as reflecting the inability to consciously perceive the extra item due to a lack of attention to it (Mack & Rock, 1998). However, participants were only asked whether they noticed the extra item or not after they finished the task. This was done to eliminate the influence of expectations on an IB level and prevent participants from doing two tasks (responding to the brightness and to the extra pattern). Thus, the measurement of visual awareness among participants was performed only on the basis of the psychophysiological correlate but not on the basis of participants' trial-by-trail verbal report. This fact raises doubts about the validity of the measurement. According to Tononi and Koch (2014), at the moment it is not clear if the ERP peak of 300 ms after the stimulus presentation is associated with the awareness or verbal report. The lack of such a response from the brain cannot be simply associated with a lack of awareness, due to insufficient data in this field (infants, animals, patients with brain lesions) (Tononi & Koch, 2014). It should also be noted that the classical paradigm of IB, applied in the study of Pitts and colleagues, does not allow independent manipulation of the processes of attention (for example, the relevance of an extra item to the task) and visual awareness.

However, there is an ERP paradigm developed by Koivisto and colleagues which is considered as allowing separate manipulation of the consciousness and attention processes (Koivisto, Kainulainen, & Revonsuo, 2009). In a number of studies these researchers have obtained a component of object-based attention — SN (selection negativity) — in a visual identification task which shows the difference in physiological reaction (ERP) to targets and distractors at an interval of 200–300 ms after stimulus onset. Also, the authors have found the component of early visual awareness — VAN (visual awareness negativity, a correlate of visual awareness) — varies depending on the masking of the target and is elicited in a 130–200 ms time window. Finding these components in IB would help in comprehending the nature of processes involved in extra item processing. In this regard, the experimental paradigm of differentiating object-based visual attention and visual awareness (Koivisto et al., 2009) was applied in our study. The goal of the present study was to examine the correlates of object-based attention (SN), early visual awareness (VAN), and as late-visual awareness (300 ms after the presentation) in the IB condition. This condition was specified as one in which participants do not notice the target, potentially accessible for conscious perceiving, but it is in the unattended field, that is, in the near absence of attention.

In M. Koivisto's experiment subjects were presented with two different letter stimuli that could be masked; subjects responded either that they saw or didn't see the target whenever it appeared in the attended field. Such a procedure allowed for variation of several factors: A) Spatial attention (reaction to targets in an attended, and in comparison with an unattended, field); B) Visual awareness (reaction to the target in a masked condition in comparison with an unmasked condition); C) object-based attention (reaction to the target in comparison with non-target).

Our study modified the procedure of the original experiment in following way:

1. Koivisto's experiment contained the instruction that restricted responses only to the attended field (rigid instruction). Attended vs unattended was varied across conditions with the help of a small arrow that showed the visual field (left or right) where the target to be presented. We kept the instruction but also added a non-equivalent distribution of the targets (1:3) that could help to redirect attention to a cued field. Our study also contained another type of instruction (non-rigid) that allowed the subject to respond to the target whenever they saw it (both in the attended and unattended fields). Distribution of the targets across the cued and uncued fields was equivalent (1:1) in this case. A non-rigid instruction was used to make it possible to measure the condition of inattentional blindness.

2. Inattentional blindness is the situation when a person fails to notice an extra item once their attention is directed somewhere else; to make it possible to measure it we used two types of possible responses — "I see" and "I don't see". The objective was to measure the physiological response when the subject answered "I don't see" in the presence of the target in the attended field. We consider this type of response to reflect inattentional blindness.

Participants. There were 17 right-handed participants in the experiment (M = 23, SD = 2); all subjects had normal or corrected-to-normal vision.

Stimuli and procedure. The stimuli were three Latin letters, "U", "H", and "T" (1.1×1.5 visual angle each). Each trial was preceded by a cue for 3000 ms. In each trial, two different letter stimuli were simultaneously presented for 17 ms, one in the left visual field and one in the right visual field. Two masks were presented bilaterally at the SOA of 33 ms and 133 ms in a masked condition. In the unmasked condition, one mask was presented unilaterally at the SOA of 33 ms, whereas in the other visual field two masks were presented at the SOA of 33 ms and 133 ms. Before the next trial the 1000 ms interval was held. The experiment consisted of a training block of 64 trials (7 minutes) and two main experimental blocks of 512 trials (38 minutes). Each block had half the trials masked and half unmasked. After 128 trials a one-minute break was included; after each block there was a two-minute break. The target letter was one letter; others were considered as non-targets within a block. Before each block the instruction was presented for 20 seconds, after which a sign saying "READY" was shown for 5 seconds. Each participant was presented with two blocks (counterbalanced) different in instruction (rigid and non-rigid). In a block with rigid instruction they were asked to respond only to the target in the cued field. The small arrow indicated the location of the target (right or left visual field) before a set of several trials. Also, there was an unequal distribution of the targets and non-targets (1:3): there were thrice as many targets as non-targets in a cued visual field. In a block with non-rigid instruction, subjects were asked to respond to the target whenever they saw it. Also, the distribution of the targets vs non-targets in the cued visual field was equal. After each trial participants had to press one of two keys: "see the target" or "don't see the target".

EEG recording. EEG recording was provided, with gold-plated scalp electrodes (Grass Instrument Co.) arranged according to the international 10/20 system (Jasper, 1958). The two mastoid bones were used as a reference and the forehead as ground. The electrodes below the left eye, on the cheek, under the eye and above the eyebrow, were used for recording electro-oculography to monitor high-amplified electrical artifacts. Electrode impedances were kept below 5 kΩ. EEG was amplified (SynAmps Model 5083) by using a band-pass of 1–30 Hz. The sampling rate was 500 Hz. For EEG, recording was performed using a Mitzar EEG computerized electroencephalograph, Calculation of EEG parameters was performed using the "WinEEG v.2.4" software (Russia).

Behavioral results

Behavioral results are shown in the Table 1.

In the unmasked condition, subjects correctly identified 80.7% of the targets in the attended field (non-rigid instruction condition) and 80.8% of the targets in the attended field (rigid instruction condition). Thus subjects could effectively distinguish between targets and non-targets when attention was drawn to the visual field. In the masked condition 64.9% of correct target identification happened under non-rigid instruction conditions, whereas 49.8% correct target identification was obtained under rigid instruction conditions. All differences are statistically significant ($p < 0.01$). Correct responses to the targets under rigid instruction conditions (unmasked unattended field) were rare (15.8%), although under non-rigid instruction conditions 54.6% of targets were identified correctly (unmasked unattended field). These behavioral results are partially consistent with those obtained by Koivisto et al., (2009). There was only a 5% false alarm rate throughout all conditions. Also, subjects' responses to unmasked targets in the unattended field were analyzed, i.e., reactions in the IB condition. Subjects didn't notice unmasked targets in 68% of cases (i.e. answered "I do not

Table 1

Correct responses to the target in different experimental conditions

Instructions		Correct target identification		Total
		In attended field	**In unattended field**	
Non-rigid instruction	unmasked	878	594	1472
	masked	706	335	1041
Rigid instruction	unmasked	1318	86	1404
	masked	813	66	879

see"). Evoked potentials (EPRs) were further analyzed in these conditions.

ERP Results

All preprocessing and statistical analysis was done in Matlab R2014b with the help of the open source EEGLAB toolbox (Delorme & Makeig, 2004); the EEG signal was filtered from 0 to 30 Hz; major artifacts and interruptions in recording were removed manually; to remove eye-movement, a connected artifacts ICA was performed (15% of the data was excluded); stimulus-locked ERPs were calculated according to the time windows in the work of Koivisto et al. (2009): P1 (90–130 мs), N1 (130–200 мs), N2 (200–300 мs), P3 (300–700 мs). We analyzed instant amplitudes, and the baseline was corrected in the time window of 200–0 ms. Areas of interest were temporal (T5, T6), parietal (P3, P4) and occipital (O1, O2) electrodes. Statistical processing was performed by Paired and Unpaired T tests, with Holmes correction for multiple comparisons. All results mentioned in the results section are statistically significant on the $p < 0.001$. Areas of interest that have statistically significant differences between the conditions are marked dark gray on figures.

There were several conditions within the group: Masking x Object-based Attention × Type of Instruction × Type of Response. The comparison of Masking x Object-based Attention conditions was done across all blocks (rigid and non-rigid instructions), while the comparison of Object-based Attention × Type of Response conditions was conducted only across the block with the non-rigid instruction. This was because we didn't obtain a sufficient amount of negative responses ("I don't see") to the unattended target in the block with rigid instruction.

Visual awareness negativity (VAN) and selective negativity (SN)

In the experiment, ERPs elicited by unmasked targets were more negative than those evoked by masked targets, from 100 to 200 ms (component N1) in the left hemisphere (O1, P3, T5 — contralaterally) (statistically significant differences between the conditions are marked on figures in dark gray). A similar tendency was obtained in the time window from 200 to 300 ms (N2) on occipital (O1, O2), parietal (P3) and temporal (T5, T6) electrodes contralaterally (N2) (Figure 1).

The data obtained are consistent with the results of Koivisto et al., as the component of visual awareness negativity (VAN) was identified. Also, a more pronounced negative peak as a reaction to the targets was detected as compared to non-targets in the 200–300 ms (N2) time interval at the occipital (O1) and temporal electrodes (T5, T6) contralaterally (Figure 2).

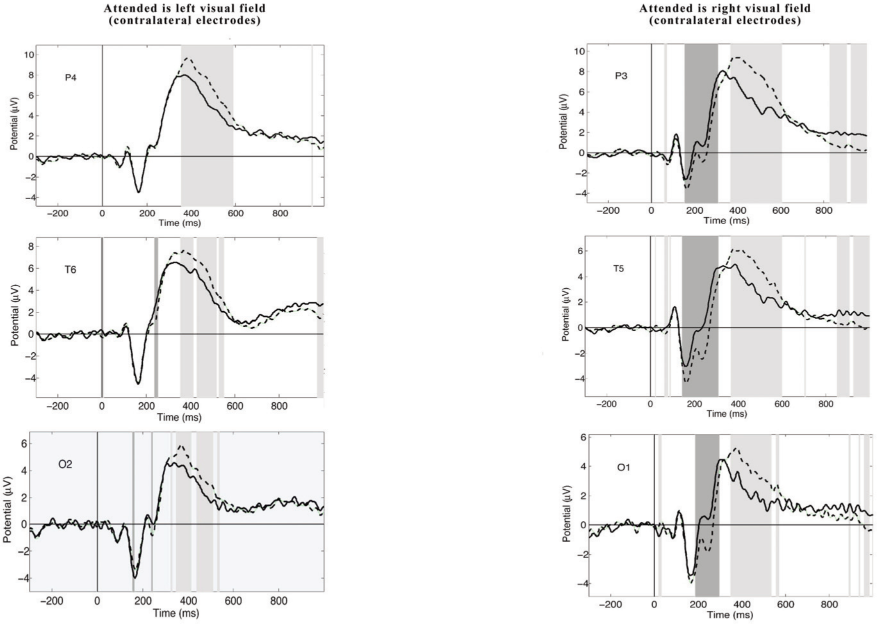
Thus, in the experiment the object-based attention (SN) factor was also detected, which is consistent with previously received data (Koivisto et al., 2009). ***Thus, the conditions necessary for the replication of M. Koivisto and colleagues' experimental paradigm have been observed, and it gives the opportunity for further analysis of data in the IB condition.***

ERPs results in the IB condition

In this study, IB was considered as a condition when subjects responded

Figure 1

ERPs in response to masked and unmasked targets in the attended field at the occipital (O1, O2), posterior temporal (T5, T6) and parietal (P3, P4) electrodes, contralateral to the right and left visual field (the masked targets condition is drawn with a solid line; the unmasked targets condition is drawn with a dashed line)



"I do not see" when the unmasked target was presented in an unattended field. There were two main comparisons performed during analysis:

– a comparison of the responses "I see" and "I do not see" to investigate if the response "I do not see" in the unmasked unattended target condition evoked more activation identifying visual awareness in IB;

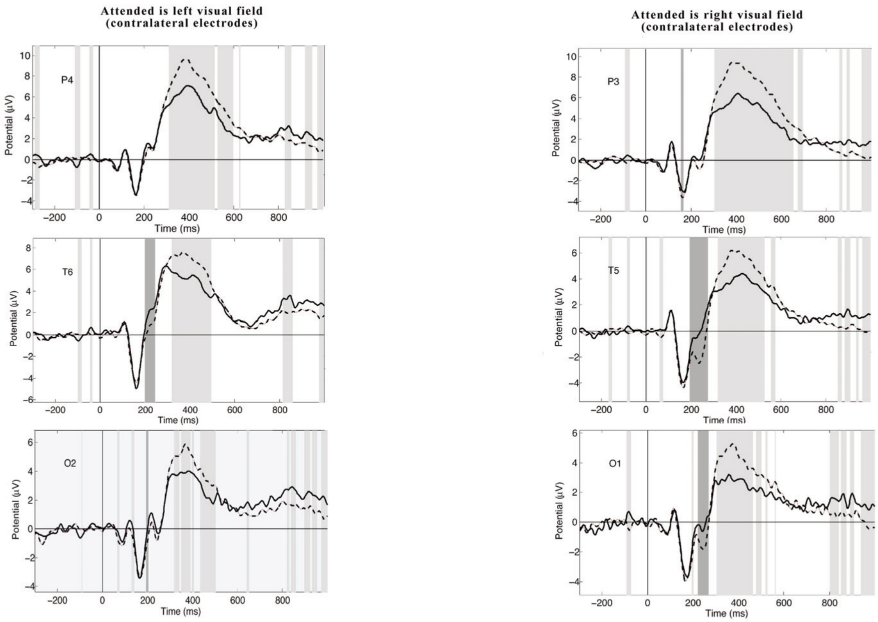
– a comparison of the reactions to the targets (only for responses "I do not see" — incorrect rejection) with the reaction to non-targets (only for responses "I do not see" — correct rejection) to find out whether targets elicit more activation than non-targets. This would imply that these two types of stimuli are differentiated when subjects respond negatively in an IB condition.

The ERPs elicited by a positive response ("I see") were found to be more positive than activation related to negative responses ("I do not see") between 300 and 700 ms after stimulus onset (P3, P4, T5, T6 — contralaterally) (Figure 3).

According to Koivisto, these differences stem from the fact that information about the stimulus in the case of a negative response ("I do not see") does not reach the final stage of processing, which leads to the lack of awareness of the visual object (P300, or LP (late positivity), 300–700 ms). ***Thus, in our study, the responses "I do not see" to***

Figure 2

ERPs in response to unmasked targets and non-targets in the attended field at the occipital (O1, O2), temporal (T5, T6) and parietal (P3, P4) electrodes, contralateral to the right and left visual field (the unmasked target's condition is drawn with a dashed line; the unmasked non-target's condition is drawn with a solid line)



unmasked unattended targets are to be given due to the absence of visual awareness.

A comparison of ERPs evoked by the targets (only for responses "I do not see" — incorrect rejection) with those to the non-targets (for responses "I do not see" — correct rejection) revealed more negative patterns to the targets in the interval from 200 to 300 ms (N2) at occipital (O1, O2), parietal (P3, P4) and temporal (T6) contralaterally. This result implies that the component of object-based attention was obtained (SN) when negative responses ("I do not see") were given to targets in IB condition (Figure 4).

This component, according to Koivisto, reflects the possibility of distinguishing between targets and non-targets. Thus, it's probable that subjects could differentiate targets and non-targets at the early stages of processing (before 300 msec) in an IB condition.

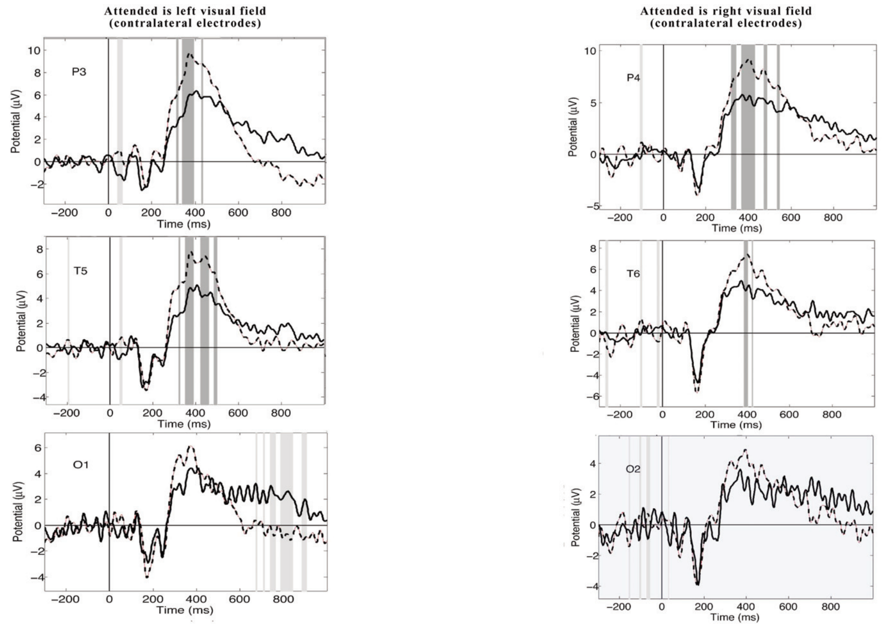
What can be concluded from these results? In the so called IB condition the correlate of object-based attention was found; but, components related to visual awareness were not detected. That is, the subjects apparently distinguish the target from the non-target, but they are not aware of this difference.

Discussion

The aim of this work was to study the correlates of attention and visual awareness in IB. The results from

Figure 3

ERPs evoked by positive ("I see") and negative responses ("I do not see") to unmasked unattended targets at the occipital (O1, O2), temporal (T5, T6) and parietal (P3, P4) electrodes, contralateral to the right and left visual field. A positive response ("I see") is drawn with a dashed line; a negative response ("I do not see") is drawn with a solid line

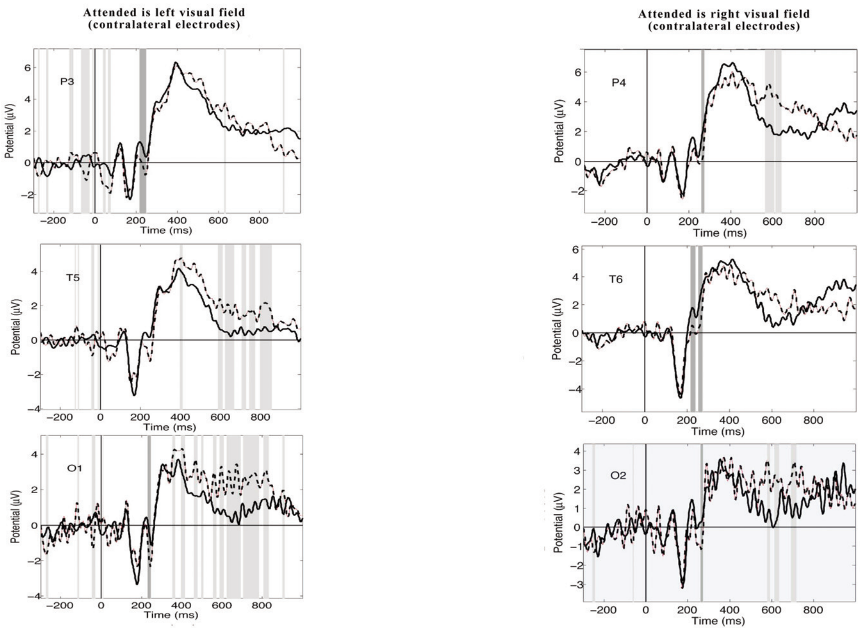


Koivisto and colleagues (Koivisto et al., 2009) were replicated. Correlates of object-based attention (SN) and visual awareness were investigated in an IB condition in which the component of selective negativity was indicated in the absence of visual awareness (P300). Earlier it was noted that in the previous IB study (Pitts et al., 2011) this late visual awareness component was again not detected. However, Pitts and colleagues have not received the data showing the involvement of object-based attention in IB. This was the reason why Pitts, Martinez and Hillyard have suggested that an extra item is not differentiated in IB (Ibid.). However, in previous behavioral studies it was shown that participants respond differently to the extra item in the IB task in comparison with the novel item that wasn't presented earlier or in comparison with the less relevant extra item (Kuvaldina, 2011; Most, 2010; Mack & Rock, 1998). Our study is consistent with these behavioral data, and does not replicate the results of Pitts et al. The differences in the obtained data are probably due to the inclusion of an extra item in the main task in our study, while in the experiment of Pitts and colleagues, an extra item is totally irrelevant to the main task.

Our findings also contradict the assumption by Raffone (Raffone et al.,

Figure 4

ERPs evoked by negative responses ("I do not see") to unmasked targets and non-targets in the unattended field at the occipital (O1, O2), temporal (T5, T6) and parietal (P3, P4) electrodes. Responses "I do not see" are drawn with dashed line, responses "I see" are drawn with solid line



2014a) that there would be no attentional components (SN) obtained during IB. This prediction was based on findings by Del'Aqua, Sessa, Jolicoeur, & Robitaille (2006). In their study the absence of N2pc[3] related to early filtering was demonstrated during the second target (T2) presentation in attentional blink condition (RSVP paradigm). According to Raffone, the lack of physiological correlates of attentional filtering implies that the attentional process is not initiated and does not lead to awareness in such phenomena as attentional blink and inattentional blindness.

But were there really no attentional correlates found in the experiment by R. Del'Aqua et al.? Their experiment used the attentional blink paradigm, where two targets were presented successively with the second target not being noticed when it was presented close in time to the first. The lack of an N2pc component was seen only when the first target in the attentional blink

[3] "N2pc typically arises at post-stimulus latencies of 180–300 msec, and consists of a more pronounced negative activation of the posterior sites contralateral to the visual hemifield where the target is presented, relative to ipsilateral sites... Luck and colleagues proposed that the N2pc reflects the process of suppressing interfering distractor stimuli in the context of target identification" (Mazza, Turatto, & Caramazza, 2009, p. 880).

paradigm consisted of digits. When it was presented as a character (“=”), the researchers found both the N2pc component and the following component related to storing of information after filtration (the sustained posterior contralateral negativity — SPCN). According to Del’Aqua and colleagues, when targets are characters they are associated with less attentional load, which leaves the possibility of detecting an extra item. Probably, such a partial load of attention took place in our study; therefore the component of object-based attention (SN) was found. Such an assumption would bind attention and visual awareness into a serial process, wherein attention provides access to further awareness. However, Del’Aqua et al. do not relate obtaining attentional components to the accuracy of verbal reports in their experiments (see similar results in Luck, Woodman, 2003). Thus, an alternative interpretation is possible, namely that attentional processing is not a prerequisite for the subsequent awareness (Cohen et al., 2012; Kentrige, Nijboer, & Heywood, 2008).

We didn’t show the lack of top-down attention in the presence of visual awareness; consequently it is hard to conclude anything about Koch & Tsuchiya’s (2007) approach on the basis of our data. We can argue against the approach of Raffone et al. (2014a) because the SN component found in the IB condition contradicts their idea about the lack of attentional amplification and ignition leading to an inability to consciously perceive the extra item in IB.

Our study showed that in an IB condition the correlate of object-based attention (SN) was detected in the absence of the conscious processing component (P300). This implies that in the IB condition the process of early stimuli discrimination might take place together with the absence of the lack of verbal reporting in later stages of processing. According to Koivisto (Koivisto et al., 2009) and Lamme (Lamme, 2003) early stages of information processing can be attributed to the “phenomenal consciousness”, subjective experience in the absence of verbal reporting. Perhaps the response “I do not see” in the IB condition in our study is associated with underachieving of the last stage of stimulus processing, which is “access consciousness”, despite the successful completion of the previous stages.

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Исследование условия слепоты по невниманию методом вызванных потенциалов

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Резюме

На данный момент в сфере когнитивной психологии большое внимание уделяется вопросу о механизмах работы сознания, в частности, различиям в функциях внимания и зрительного осознания. В связи с этим особый интерес представляют иллюзии внимания, такие как мигание внимания, слепота по изменению, слепота по невниманию, которые, возможно, демонстрируют наличие одного из процессов в отсутствие другого.

Данная работа посвящена исследованию слепоты по невниманию и поиску психофизиологических коррелятов зрительного осознания (visual awareness negativity, VAN) и объектно-ориентированного внимания (selective negativity, SN) в нем. В эксперименте была использована модифицированная методика М. Коивисто (Koivisto, Kainulainen, & Revonsuo, 2009), позволяющая манипулировать факторами зрительного осознания и привлечения внимания. Задача испытуемых состояла в поиске целевого стимула среди дистракторов с подсказанной стороны, при этом стимулы могли быть маскированы или нет. В качестве условия слепоты по невниманию рассматривалось предъявление цели в поле невнимания. Было показано, что в условии слепоты по невниманию наблюдается компонент объектно-ориентированного внимания (SN), что говорит о способности испытуемых к различению цели и дистрактора. При этом не был получен поздний коррелят (P300), связываемый со зрительным осознанием цели в условии слепоты по невниманию. Можно заключить, что слепота по невниманию связана с различением стимулов на ранних этапах переработки зрительной информации и отсутствием вызванного потенциала на поздних этапах переработки.

Ключевые слова: слепота по невниманию, сознание, негативность зрительного осознания, компонент объектно-ориентированного внимания.