Doctoral School of Psychology of the University of Pécs
Evolutionary and Cognitive Psychology Doctoral Program

Exploring the effects of threatening stimuli on visual search performance using different experimental designs

Theses of Doctoral (PhD) dissertation

András Norbert ZSIDÓ

Consultants:
Dr. Anita DEÁK, PhD
Dr. László BERNÁTH, habil. PhD

2018
Pécs

1. General Introduction

There are three main possibilities (Storbeck & Clore, 2007) to describe the relationship between cognitive processes and emotions in general. The first one states that cognitive and emotional processes are independent. The second underscores the role of emotion as a prime factor. While the third one states that emotions are automatic responses to perceived cues that guide the different cognitive processes, e.g. attention (see also Pataki, 2002). There is a fourth possibility described by Pessoa (2013), who claims that emotions and cognitive processes interwork or interact, i.e. act one upon the other. The present dissertation uses the notion claimed by Pessoa. However, it is inevitable to first operationalise the main compounds, namely the cognitive process we are going to explore, and how we define emotions.

Thus, the goal of the present dissertation is twofold. First, to show the interaction as Pessoa (2013) described it, using various experimental paradigms (e.g. Study 1, Experiment 1; Study 2, Experiment 1) and different emotions. Hence, Experiment 1 of Study 3 includes other emotions than fear as well. However, this is the only one to do so and the reason behind our decision to focus on negative emotions, and fear, in particular, was that even one emotion offers so much possibility, that without a definite focus, the in-depth analysis using different methodologies would not be a possibility; or at least that would not be within the range of a dissertation. The second goal and the reason that draw our attention to fear is the very interesting debate regarding the possible differences of processing cues with evolutionary and modern origin. The main question is whether these stimuli with different origins are processed differently, or we process them using the same pathway. That is evolutionary relevant threats are processed automatically (Gao, LoBue, Irving, & Harvey, 2017; Isbister & White, 2004; see Öhman & Mineka, 2003 for review) as this was crucial in the survival of the human species, while the processing of modern threats might be faster than neutral cues but not automatic. In contrast, others (Fox, Griggs, & Mouchlianitis, 2007; Sander, Grafman, & Zalla, 2003; Sander, Grandjean, & Scherer, 2005; Subra, Muller, Fourgassie, Chauvin, & Alexopoulos, 2017) claim that modern threatening stimuli that are feared, use the same pathway, or at least the result of procession is the same, i.e. rapid detection and response.

2. STUDY 1 – THE CLASSICAL VISUAL SEARCH TASK

2.1 Experiment 1 – The role of modern threatening cues

2.1.1 Aims and hypotheses

We claim that besides evolutionary old stimuli, modern threatening cues must be considered, while arousal should have a highlighted role in this comparison. The overall impression from past research (Blanchette, 2006; Brown, El-Deredy, & Blanchette, 2010; Öhman & Mineka, 2001; Purkis & Lipp, 2007) is that it is not evident whether evolutionary relevance means there is an advantage in visual processing and responding. It is still a question whether evolutionary old threatening stimuli have an advantage over modern threatening ones. In our view, it is possible that arousal state causes the conflicting and inconsistent results. The present study, and the experiments within is the first to compare modern and evolutionary relevant stimuli in a visual search task where the effects of the context and the level of arousal are also considered. Our hypothesis was that arousal does have a crucial role in the evaluation of a threatening cue, and higher levels of it would mean faster detection.

2.1.2 Method

The basic paradigm adopted in this study is the well-established visual search task (Fox et al., 2007; Öhman, Flykt, & Esteves, 2001). In their studies, four or nine pictures are presented at the same time in a matrix array, and participants have to determine whether the previously specified target was present or absent. However, the present paradigm differs from the classical VST in some regards. For instance, in these previous studies, they directly compared the detection of fear-relevant (snakes and guns) stimuli, however, they did not control for the arousal level of the stimuli. An important feature of our experimental design is that two arousal categories were introduced (medium and high), allowing us to investigate the specificity of the fear module.

2.1.2.1 Participants

Fifty-three university students (21 men and 32 women, mean age 21.4 years, ranging from 19 to 23 years) volunteered in the experiment. The sample size for this experiment was determined by computing estimated statistical power ($\beta > .8$), based on the results of prior experiments on fear advantage using the odd-one-out visual search task (Blanchette, 2006; Fox et al., 2007).

2.1.2.2 Experimental stimuli

The experimental stimuli consisted of target and distractor pictures. The target pictures were threatening, while the distractors were neutral. Sixteen threatening target pictures (snakes and guns) were taken from the International Affective Picture System database (Lang, Bradley,

& Cuthbert, 1997) based on the Hungarian standards (Deák, Csenki, & Révész, 2010). The level of valence was controlled and arousal was manipulated. A pilot study was conducted on an independent sample of 36 undergraduates to validate the valence and arousal ratings of the selected pictures. In order to avoid the confounding effects of low level visual features, we analysed the target stimuli based on visual features: colour brightness, contrast, luminance, and spatial frequency. Neutral distractors (flowers and cell phones) were collected from the Internet. To ensure that the neutral distractors were similar in valence and arousal, a pilot study was carried out with 47 undergraduate students who saw the pictures in random order and rated them on two 9-point Likert-type scales: valence and arousal.

The targets were presented in every possible location; in the smaller set size this meant four, and in the bigger set size, nine possible places. We used four types of targets (medium-arousal snake, high-arousal snake, medium-arousal gun, and high-arousal gun) and two types of distractors (flowers or cell phones). That is, for the smaller set size, 4 (location) x 4 (type of target) x 2 (type of distractor), and for the bigger set size, 9 (location) x 4 (type of target) x 2 (type of distractor). Thus, we had 104 stimuli where there was a target present; half of them with congruent and half with incongruent contexts. Each cue was repeated 26 times. To avoid habituation and automatic responses, participants also saw 104 target-absent pictures, where there were only distractors without a target, resulting in 208 stimuli altogether.

2.1.2.3 Procedure

First, participants saw a fixation cross for 500 ms. This was followed by a stimulus, that either contained a target (e.g. a gun among flowers) or not (e.g. only flowers). Participants' task was to indicate the target's presence or absence using different keys on the keyboard.

2.1.3 Results

The statistical analyses were performed using the JASP Statistics Program (Version 0.7 for Windows). We checked for errors and excluded the outliers, which were greater than ±3 standard deviations of the group mean (< 2% of all the collected data). The missing data were replaced by the mean of the given variable. The reaction time (RT) responses were analysed with a repeated-measures analysis of variance (*r*ANOVA) with factors as the type of distractors (flower or cell phone), set size (2x2 or 3x3), arousal (medium or high) and evolutionary age (snake or gun) as a within-participants factor.

The two types of threatening targets differed ($F(1,52)=24.2$, $p<0.01$, $\eta_p^2 = .32$). Participants found non-evolutionary targets faster than evolutionary ones. Significant interaction was found between evolutionary age and arousal ($F(1,52)=6.8$, $p<0.05$, $\eta_p^2 = .12$). Interestingly, the two types of stimuli did not differ when presented at a medium arousal level; however, in the case of a high arousal level, they did. Participants found the modern threatening stimuli faster than the evolutionary old threatening ones.

2.1.4 Discussion

We found that participants detected modern threatening pictures faster than ancient ones. This finding may be the behavioural manifestation of the stronger P1 amplitude increment for evolutionary modern over old stimuli that were shown by Brown et al. (2010). They concluded that there was no difference between evolutionary old and modern cues; it must be highlighted that they used knives and syringes as modern fearsome stimuli, although they are not the best representatives of the category. In the theoretical background of our study, we investigated past research and proposed that the best representative of the modern threatening category is the gun. In line with the suggestion of Öhman & Mineka (2001) that guns are a specific category of modern stimuli that is strongly associated with danger and death, and they are lethal from a distance, thus giving people less time to react. Thus, we conclude that these facts, along with growing up in an industrialised environment, can result in faster response time to the best representative of modern threats over evolutionary fearsome stimuli.

2.2 Experiment 2 – Testing the reactions of specially trained firemen to threat

2.2.1 Aims and hypotheses

In the present experiment, our goal is twofold: First, to test how a group of firemen with special previous training would perform in the classic visual search task. Second, to compare the results between this group to a control group of young adults without any previous training. To our best knowledge, this is the first study to assess firemen and controls on the same visual search task. According to previous research (Hemmatjo, Motamedzade, Aliabadi, Kalatpour, & Farhadian, 2017), our hypotheses are that firemen would have similar results to students, i.e. they would find modern threatening cues faster than evolutionary relevant ones. Moreover, we predict that they would be faster overall on the same task when compared to students.

2.2.2 Method

2.2.2.1 Participants

Twenty-two firemen (between the age of 25 to 45, all of them are males) participated in the experiment during the Healthcare Day of the Baranya Country Organisation for Rescue Services, which was a mandatory program for the participants. Data from two participants were excluded because of failure to follow instruction.

2.2.2.2 Experimental stimuli and Procedure

The exact same stimuli set was used as described in Experiment 1. The procedure was the same as in Experiment 1.

2.2.3 Results

2.2.3.1 Comparison of the two samples

We found two two-way interactions. The first one is a tendency between the type of target and group ($F(1,73)=3.53$, $p=.06$, $\eta_p^2 = .03$). The group of firemen found guns faster than the group of students, however, students were able to detect snakes more quickly compared to firemen. See Figure 5 for the interaction. Groups also differed in the reaction to the two set sizes – as it is seen from the set size X group significant interaction ($F(1,73)=5.34$, $p<.05$, $\eta_p^2 = .07$). The performance of students was not affected by the number of pictures present, i.e. 2x2 or 3x3; however, interestingly, the performance of firemen did change. They were faster to find the target in smaller matrices; compared to students, and the bigger set size. Moreover, they were slower to find the target in bigger matrices, again, compared to students and the small set size. The other interactions and the within-subject factor was not significant ($p>.1$).

2.2.4 Discussion

It seems plausible to claim that people having a dangerous profession found modern threatening cues faster, even if they have not received previous training involving weapons. Although, mainly as a consequence of the age gap, many of the firefighters reported that they have been recruited as enlisted men (mandatory service in the army) as young adults. Moreover, the significant interactions are highly interesting and surprising in the sense that processing of threatening stimuli is considered as automatic (Öhman et al., 2001; Öhman & Mineka, 2001), which means that they could be found equally as fast regardless of the number of distractors around them. One possible explanation for this result would be that a non-automatic process happens right after the automatic process. That is, subjects automatically detect the threatening target, and then 'double-check' the visual field once again to make sure they identified the target correctly. As it is important not to forget that in 50% of the cases there was no target present. Subjective reports after completing the task seem to support this. The majority of the participants wanted to know how accurate they were, and they tried to compete with their peers with their results. Further studies should take these motivational and subjective variables into account as well, even though this might be hard to control for in such an experiment.

2.3 Experiment 3 – The underlying mechanisms of detecting threatening cues with different origins

2.3.1 Aims and hypotheses

To this date, there is no research using the classical VST in order to directly compare evolutionary old and modern threatening stimuli that are both familiar to children in a sense that they reportedly had encounters with them. The aim of our research is to fill this gap. Based on the literature review, it appears that the advantage for evolutionary cues is driven by general features, such as perceptual properties of the threats (Coelho & Purkis, 2009; Davey, 1995). On the contrary, we predict that for modern stimuli the detection is based on a sufficient amount of similarities with the exemplar (Nosofsky & Johansen, 2000; Osherson & Smith, 1981) of a given category. Our hypothesis was that both types of threatening cues are found equally as quickly, and faster than non-threatening cues.

2.3.2 Method

We directly compared modern and evolutionary relevant threatening and non-threatening targets among neutral distractor images (both modern and ancient) that never served as targets, to avoid any confusion. Thus, a 2x2x2 design was used with the type of background (i.e., evolutionary and modern), the origin of the target (i.e., evolutionary and modern), and threat level of the target (i.e., threatening vs. neutral) as fixed factors.

2.3.2.1 Participants

Sixty-eight (33 girls, 35 boys) preschool children participated in our experiment in exchange for small gifts (i.e. stickers or erasers). Their mean age was 5.5 years (S.D. = 0.6). All of them were right-handed with normal or corrected-to-normal vision, as reported by their parents.

2.3.2.2 Stimuli

The stimuli consisted of targets and background images. All of the pictures were taken from the internet. There were four types of targets based on the level of threat (fearful and neutral) and the evolutionary age (modern and old). We sourced nine exemplars of each target category. Spiders were used as evolutionary threats, and ladybirds as a neutral control; the modern threatening cues were pictures of syringes, and pens were used as a neutral control (Quinlan, 2013; Quinlan, Yue, & Cohen, 2017). When sourcing the images, steps were taken to attempt to control and match the pose of the respective threatening cues with their neutral counterparts. Ratings of the threat of images were assessed using a visual analogue scale (transformed to scores 0–100, higher scores mean higher perceived threat level) by our participants after completing the visual search task. The threatening targets (evolutionary relevant $M = 69.12$, $SD = 46.54$; modern $M = 66.18$, $SD = 47.66$) were rated as more threatening than the non-threatening ones (evolutionary relevant *M* = 11.77, *SD* = 32.46; modern *M* = 10.29, *SD* = 30.61; $F(1,67) = 133.35$, $p < 0.01$), the modern and ancient threatening and non-threatening groups did not differ from each other, and there was no interaction between type and origin of the stimulus (*F*s < 1, *p*s > 0.1). All participants reported that they are familiar with the targets, i.e., they have previously encountered them on more than one occasion. In each case, this was also confirmed by one of their parents.

After collecting the images, we used the Spectrum, Histogram, and Intensity Normalization and Equalization (SHINE) toolbox (Willenbockel et al., 2010) written with MATLAB to control the low-level visual features (luminance, contrast, spatial frequency). The matching steps were applied to the whole images. All the images (threatening, non-threatening targets, and backgrounds) were loaded in the program and converted to grayscale, then, the low-level properties were equated among them.

2.3.2.3 Procedure

A cheerful emoticon was displayed. The child had to place their right hand on a sheet of paper on the desk in front of them. When the experimenter saw the child is ready, the trial was started. First, children saw a fixation cross for 500 ms, followed by a stimulus. The task was to indicate the location of the target using a touch-screen monitor.

2.3.3 Results

Reaction times were averaged over trials yielding eight variables based on three factors: type of background (i.e., evolutionary and modern), the origin of the target (i.e., evolutionary and modern), and threat level of the target (i.e., threatening vs. neutral). These were then entered in a three-way repeated measures ANOVA as fixed factors. Please note that the results have been corrected for multiple comparisons using the Benjamini–Hochberg procedure. The analysis revealed statistically significant main effects of threat level ($F(1,66) = 41.68$, $p < 0.01$, $\eta_p^2 = .39$) such that participants found threatening targets faster. The main effect of background was also significant ($F(1,66) = 400.244$, $p < 0.01$, $\eta_p^2 = .86$), indicating that the targets were detected more quickly on the evolutionary relevant background. In sum, the main effect of threat level revealed that children found threatening images (*M* = 1.90 sec, *SD* = 0.20) faster than they found non-threatening images (*M* = 2.01 sec, *SD* = 0.26), and were systematically faster when evolutionary old pictures served as background (*M* = 1.81 sec, *SD* = 0.21), compared to modern (*M* = 2.11 sec, *SD* = 0.26) ones.

2.3.4 Discussion

We investigated whether the perception and detection of evolutionary relevant and modern threatening cues are equally quick while controlling for several important variables such as background – *context* –, the shape of the target, and low-level visual features. We have found that children spot the threatening targets more quickly compared to the neutral ones.

Furthermore, if we compare these results to those of the evolutionary relevant stimuli, the children found the threatening cues equally as quickly. Therefore, we claim that as young as preschool children detect threatening cues faster, regardless of the evolutionary origin of the cues, if they have previous negative experience with them. Hence, we support the findings of previous research (Blanchette, 2006; LoBue, 2010b) that arrived at the conclusion that threat-relevancy matters the most.

2.4 General Discussion

In sum, we claim that the three experiments presented here take us closer to the understanding of how threat detection, fear acquisition occurs and what is the unique role of each factor that is present. Preschool children are seemed to be visually prepared to detect well-known – i.e. had previous experience with – threats quickly, and this might be generalised to further stimuli that one considers threatening but have no previous experience with (e.g. gun for students). Moreover, with the inclusion of a special sample of firemen, we could also investigate individual differences that should be also considered and mapped by future research. To date, we do not know whether biological predisposition or careful training could account for the differences better. That is people become firemen because they could tolerate stress and high arousal more, or people who became firemen learned to cope with stress better.

3. STUDY 2 – PROPOSING A NOVEL PARADIGM TO INVESTIGATE THE DETECTION OF THREAT-RELEVANT CUES

3.1 Experiment 1 – Pilot study

3.1.1 Aims and hypotheses

First, we wanted to test our proposed paradigm, thus Experiment 1 is a pilot study to explore the weak and strong points of the method and to allow us to make necessary changes for further testing.

3.1.2 Methods

3.1.2.1 Participants

Fifty-five participants (20 male, 35 female) were recruited from students of the University of Pécs, with a mean age of 22.6 (S.D. = 2.01).

3.1.2.2 Materials

All images (both background and target) were collected from the Internet. We sought for neutrally valanced backgrounds that could be either evolutionary relevant (e.g. forest, natural scenes) and modern (e.g. street, factory) images depicting real-life scenes. Then, all pictures were resized to 800x600 pixels. After this, we also made some adjustments regarding their basic visual features (namely luminance, contrast, and colour intensity) to avoid the possible confounding effects. After creating a large set of pictures, we conducted an online pilot study with 40 University students to assess valence, arousal and threat ratings of all the images. Respondents had to rate the pictures on 9-point Likert-type scales regarding valence (1 – very negative, 9 – very positive), arousal (1 – not arousing at all, 9 – very arousing), and perceived threat (1 – not threatening, 9 – very threatening). The selection of target pictures went similarly. First, we collected a big database of images depicting a snake, a spider, a knife, or a gun, and then, resized them to 45x45 pixels. The same low-level visual feature filtering procedure was applied to them as for the background images. The same 40 students rated the targets (after completing the rating of the background pictures), and we selected the targets used in the experiment based on these ratings.

3.1.2.3 Procedure

First, participants saw a fixation cross for 500 ms, then a real-life scene appeared with one of the target objects on it. Participants' task was to find the target as quickly as possible and indicate the target's location using a touch-screen monitor.

3.1.3 Results

We excluded inaccurate responses using an outlier flagging procedure with a two-standard-deviation criterion on the raw data of coordinates. Reaction time data were deleted in these cases (<1%) and were considered as system missing during further analyses. None of the measurements deviated from the normal distribution, neither the assumption of variances nor sphericity were violated. The statistical analyses were performed using the JASP Statistics Program (Version 0.7.5 for Windows).

Participants found modern threatening targets faster than evolutionary old ones, irrespective of the background. The evolutionary relevant target category had two types of stimuli: spider and snake. To analyse whether they act differently in the two contexts, we used a 2x2 ANOVA: Background (evolutionary relevant and modern) and Type of Evolutionary relevant target (spider and snake) were the two main factors. The analysis yielded a significant interaction between the two main effects ($F(1,54)= 47.26$, $p<.01$, $\eta^2=.47$), while the two main effects were not significant (both ps $>.05$). Participants found spiders faster in a modern context – compared to snakes in modern context and spiders in an evolutionary context; while they were faster to respond to snakes in an evolutionary background when compared to snakes in a modern setting or to spiders in an evolutionary one.

3.1.4 Discussion

Our results suggest that people tend to find modern threatening targets faster than evolutionary relevant ones. However, the context plays an important role. We claim that the interaction between the background and the subtype of the stimuli can be interpreted as a priming effect that can change how people look at different cues. One might argue that both knives and guns are irrelevant in an evolutionary setting because they are modern threatening targets.

We think that the new paradigm presented here could be used in further testing of threat detection with the necessary changes and correcting for the flaws that were shown in this pilot study. The results of these studies may add to the better understanding of threat detection, and to either support one of the previously described theories or show a way to merge them and create a new one.

3.2 Experiment 2 – Comparing the best representatives of modern and evolutionary relevant threatening stimuli

3.2.1 Aims and hypotheses

Again, the main goal of the present study was to test whether evolutionary threatening cues have an advantage over neutral and modern threatening ones, or threatening cues have an advantage over neutral ones regardless of the origin. Maybe none of this is true and as Quinlan (2013) suggests there is no threat advantage at all. In Experiment 2, we use the best representative (see e.g. Öhman et al., 2001; Fox et al., 2007; LoBue & DeLoache, 2008) of the modern (gun) and evolutionary relevant (snake) threatening categories and compare them with neutral cues. We hypothesised that threatening targets are found faster compared to neutral ones regardless of evolutionary relevance.

3.2.2 Methods

3.2.2.1 Participants

Thirty-four participants (16 men, 18 women) were recruited from students of University of Pécs, with a mean age of 21.3 (S.D. = 1.78). The sample size for this experiment was determined by computing estimated statistical power ($\beta > .8$), based on the results of prior experiments on fear advantage (Blanchette, 2006; Fox et al., 2007; Öhman et al., 2001).

3.2.2.2 Materials

A set of pictures depicting real-life scenes (background images) and target objects were collected from the internet. Each target was added to the backgrounds with digital editing. Eight neutral background pictures of the same size (800 x 600 pixels) were collected from the Internet. Half of these pictures depicted natural scenes (e.g. forest, riverside), the other half depicted modern ones (e.g. street, factory). We, then, collected four types of target pictures: evolutionary relevant threatening (snake) and non-threatening (cat), and modern threatening (gun) and non-threatening (pen). Each category included three different pictures of the object. All targets had the same size (50x50 pixels, i.e. visual angle 1.26°x1.26°). None of the background pictures contained any similar objects, and neither humans nor animals were present on them.

To avoid the possible confounding effects of uncontrolled variance in low-level visual properties, we used the Spectrum, Histogram, and Intensity Normalisation and Equalisation (SHINE) toolbox for MATLAB (Willenbockel et al., 2010) to ensure that our background pictures were equivalent with respect to luminance, contrast, and spatial frequency. As a result, all the images used were grayscale. Image complexity was also calculated for all the final pictures, to control for the possible confounding effects of variance in visual complexity (Donderi & McFadden, 2005; Forsythe, Nadal, Sheehy, Cela-Conde, & Sawey, 2011).

3.2.2.3 Procedure

See Experiment 1 for an overview of the trial presentation sequence.

3.2.3 Results

First, we searched for inaccurate responses. We did this using an outlier flagging procedure with a two-standard-deviation criterion on the raw data of coordinates. Reaction time data were deleted in these cases (<1%) and were considered as system missing during further analyses. None of the measurements deviated from the normal distribution, neither the assumption of variances nor sphericity were violated. The statistical analyses were performed using the JASP Statistics Program (Version 0.7.5 for Windows). We used a 2x2x2x2 ANOVA to analyse the dataset with the background (evolutionary relevant vs. modern), the origin of stimuli (evolutionary relevant vs. modern), type of stimuli (threatening vs. neutral), and position (inner vs outer circle) being the fixed factors.

The type of the stimuli yielded a significant effect ($F(1,33)=8.57$, $p<.01$, $\eta^2=.21$). Participants were faster to find threat-relevant stimuli (snake and gun) than neutral ones (cat and pen). The position of the target was also significant ($F(1,33)=57.93$, $p<.01$, $\eta^2=.64$) such that targets on the inner circle were found faster than when they were presented on the outer one.

3.2.4 Discussion

Taken the best representative of the modern and evolutionary relevant threat categories and comparing them to neutral stimuli using a new behavioural paradigm. Our results show that the new method we proposed respondents tend to find threatening targets faster than neutral ones, regardless of their origin. Moreover, the significant effect of position underscores the importance of controlling for this variable, i.e. distance of targets from the fixation cross, in future experiments. In conclusion, the results of our second experiment suggest a relevance superiority effect over the evolutionary fear module, i.e. threatening targets are found faster compared to neutral cues regardless of the evolutionary relevance.

3.3 Experiment 3 – Does fear have an advantage after all?

3.3.1 Aims and hypotheses

The motivation behind conducting the third experiment was to test whether the main effect of threat shown in Experiment 2 is specific to the best representatives (i.e. snake and gun) widely used in former experiments or can be generalised to all threatening cues. Hence, in the present experiment, we broadened these categories and included several more objects.

3.3.2 Methods

Experiment 3 was similar to Experiment 2 in every aspect but one: there were more types of targets in both the evolutionary relevant and modern categories.

3.3.2.1 Participants

Thirty-three participants (15 men, 18 women) were recruited from students of University of Pécs, with a mean age of 22.1 (S.D. = 1.59), matching the sample size of Experiment 2.

3.3.2.2 Materials

We collected 24 background images (800X600 pixels) in total (including the previously used 8 from Experiment 2). Four types of target categories were used and pictures were sourced from the Internet: evolutionary relevant threatening (snake, sider, and scorpion) and non-threatening (cat, bird, and turtle), and modern threatening (gun, knife, and syringe) and non-threatening (pen, flashlight, and toaster). Preparation of the final image set was identical to that of Experiment 2.

3.3.2.3 Procedure

The procedure went the same as described in Experiment 2.

3.3.3 Results

First, inaccurate responses were identified using an outlier flagging procedure with a two-standard-deviation criterion on the raw data of coordinates. Reaction time data were deleted in these cases (<1%) and were considered as system missing during further analyses. The statistical analyses were performed using the JASP Statistics Program (Version 0.7.5 for Windows). We had four factors, thus, a 2x2x2x2 ANOVA was used to analyse the dataset where: the background (evolutionary relevant vs. modern), the origin of stimuli (evolutionary relevant vs. modern), type of stimuli (threatening vs. neutral), and position (inner vs outer circle) served as the fixed factors.

Strikingly, only one main effect, the position was significant ($F(1,32)=121.59$, $p<.01$, $\eta^2=.79$). As expected, participants found targets faster on the inner position compared to when they appeared on the outer circle. We also found two significant two-way interactions between origin X position ($F(1,32)=10.67$, $p<.01$, $\eta^2=.25$), and background X position ($F(1,32)=11.45$, $p<.01$, $\eta^2=.26$). Modern targets were found slower on the outer circle compared to evolutionary ones; which effect was not present when targets appeared in the inner positions. Same was true for the other interaction: targets were found slower on modern backgrounds when present in outer positions compared to evolutionary backgrounds; while they were found equally fast in inner positions regardless of the type of background.

3.3.4 Discussion

In the third experiment, we compared four categories: evolutionary relevant and modern threatening stimuli, and evolutionary relevant and modern neutral cues. More representative for each category was used compared to our second experiment in order to acquire a broader picture of the underlying mechanisms of threat detection. Interestingly, our results suggest that there is no difference in the detection of threatening and neutral cues, which is in accordance with the suggestion of some recent research (Quinlan, 2013; Quinlan et al., 2017; Yue & Quinlan, 2015). This could also be connected to the significant learning effect in time-on-task. That is, we could not show any significant difference because our participants reacted too quickly. The other possibility is that tasks focus overwrites the original startle reaction caused by fear.

3.4 General Discussion

Our goal was, beside the methodological innovation, to find clear evidence in the dispute over fear advantage. In three experiments, we test whether threatening targets have an advantage in visual detection, and if so, whether those with evolutionary relevance are highlighted in visual processing compared to modern cues. In Experiment 2, we used the best exemplars of the evolutionary relevant and modern categories, the snake and the gun, respectively. Our results suggest that there is an advantage for threatening cues over neutral ones, regardless of the evolutionary age. This supports the relevance superiority effect (see e.g. Fox et al., 2007; Subra et al., 2017).

People are particularly prone to the rapid visual detection of snakes and guns. These two specific threatening cues seem to excel from others. This finding calls for a new theory that incorporates previous ones positing the existence of a bias to highly threatening cues that evolved during evolution or acquired through social connections during the ontogenesis.

4. STUDY 3 – COUNTING ON AROUSAL

4.1 Experiment 1 – Introducing a novel method to assess the effects of emotionally charged cues on cognitive performance

4.1.1 Aim and hypotheses

Our over-arching goal was to create a better paradigm to hypothesis testing and to address the problems with the odd-one-out paradigm. In our first experiment, beyond methodological innovation, we emphasised each emotional dimension – valence and arousal – in turn, to determine which one had a greater impact on cognitive processing. Our hypothesis was that negative valence will have a bigger impact on visual search performance compared to neutral and positive valence.

4.1.2 Method

We designed a new visual search task with two components, a background picture and a number matrix in the foreground. The number matrices we used were all produced specifically for the research, using a specially written computer programme. Figure 16 shows an example of the final version of the stimulus assembly.

4.1.2.1 Participants

The sample comprised 117 volunteers – 79 men, 38 women who had not taken part in the pilot study. The participants were senior high school students or undergraduate students and their ages ranged from 18 to 26 years (*M* = 22.23, *SD* = 2.42).

4.1.2.2 Visual display

All pictures were taken from the International Affective Picture System database (IAPS) (Lang, Bradley, & Cuthbert, 1999). The pictures were collected based on the Hungarian standard values (Deák et al., 2010). The ratings were confirmed in an independent sample of 37 undergraduates. We used six categories: two neutral, two threatening (negative valence) and two with positive valence. The visual search task consisted of searching numbers in matrices created using a special matrix generator programme (download from *http://baratharon.web.elte.hu/nummatrix/*). The matrices were superimposed on the pictures, one matrix on one picture, with 50% transparency, so one could see both the picture and the numbers clearly.

4.1.2.3 Procedure

First, participants saw a fixation cross for 200 ms, then a number matrix superimposed (with 50% transparency) on an emotionally charged or neutral picture appeared. Participants' task was to find the numbers in ascending order starting with number one. Each stimulus was shown for 40 seconds, then a black screen appeared, and participants were asked to write down the last number they found. In Experiment 1 and 2 we relied on participants' self-report results. However, in Experiment 3 participants also had to indicate each number's location they found using a touch-screen monitor while performing the task.

4.1.3 Results

We checked for errors in the data and excluded the outliers (values more than 3 standard deviations from the mean; < 2.5% of all data). The missing data were replaced by the mean for that variable. Visual search performance was indexed by counting score (the number reached during the visual search). We carried out MANOVA with counting score as the dependent variable and valence (three levels: negative; neutral; positive) and arousal (two levels: high; medium) as independent variables. There was no main effect of valence ($F(2,232) = 1.645$, $p > .05$) or arousal ($F(1,116) = 1.220$, $p > .05$) but, interestingly, there was a valence x arousal interaction ($F(2,232) = 4.573$, $p < .05$, $\eta_p^2 = .04$).

4.1.4 Discussion

We examined how threatening stimuli influenced visual search performance compared to neutral and positive emotional stimuli, taking their arousing properties into account. We used a new paradigm in which the cognitive task and the emotional picture were introduced to the visual field simultaneously and present throughout an entire trial. The cognitive task involved searching a number matrix and was superimposed on an image. Our results corroborate previous results (e.g. Lundquist et al., 2014; Öhman et al., 2001; Trick et al., 2012) suggesting that valence and arousal have different effects on search performance.

Nonetheless, we showed that our new paradigm can be used for future research and is a valid method for testing the effects of emotionally charged stimuli on visual search performance. We also demonstrated that it is very important to control the level of arousal because it can influence the effect of negative valence on visual search performance. Our results raised the issue of whether differences between performance with the two negative pictures were due to differences in arousal or evolutionary origin, so we conducted a second experiment to address this question.

4.2 Experiment 2 – The comparison of threating cues with different origins using the counting task

4.2.1 Aims and hypotheses

In the second experiment, we investigated the long-established issue of the relevance of the evolutionary history of stimuli, to determine whether phylogenetic age conveys a temporal advantage in visual information processing.

In Experiment 1 we showed that the paradigm we introduced is appropriate for measuring emotional effects on visual cognition. In Experiment 2 we investigated the specific questions of how evolutionary age and arousal level influence visual processing of threatening stimuli. The goal of Experiment 2 was to investigate whether the inconsistent results of previous research on the impact of threatening stimuli on visual search can be attributed to differences in arousal, by comparing visual search performance with ancient and modern threatening stimuli as backgrounds.

4.2.2 Method

4.2.2.1 Participants

Sixty-one university students – full-time and part-time –took part in our experiment voluntarily. None of them had participated in the pilot studies (IAPS picture rating; number matrix pilot study) or in Experiment 1. The participants (50 women; 11 men) ranged in age from 18 to 39 years (*M* = 26.38; *SD* = 7.01).

4.2.2.2 Visual display

As in Experiment 1, all pictures were taken from the IAPS (Lang et al., 1997). The Hungarian standards (Deák et al., 2010) did not include enough pictures of snakes and guns so after collecting these pictures based on content from the original database, we conducted a pilot study, asking 37 independent undergraduates to assess the valence and arousal level of the pictures. We then selected pictures with similar ratings for valence and arousal level, but different content. We used the same matrix generator programme as in Experiment 1 to create the matrices for this experiment.

4.2.2.3 Procedure

The procedure was same as in Experiment 1.

4.2.3 Results

We checked for errors in the data and excluded the outliers (values more than 3 *SD* from the mean; < 2.5% of all the collected data). The missing data were replaced by the mean for the relevant variable. Counting values were used as an indicator of visual search performance, i.e. as the dependent variable. We carried out MANOVA with content (neutral; snakes; guns) and threat level (none; low; high) as independent variables.

As expected, based on the result of Experiment 1, there was a main effect of threat level ($F(2,120) = 6.41$; $p < .05$, $\eta_p^2 = .09$). Interestingly, there was no main effect of content and no interaction between threat level and content (*F*s < 1, *p* > .1). Further analyses revealed that the low-threat pictures had a negative impact on search performance (*M* = 18.43, S*D* = 3.81) compared to neutral pictures (*M* = 19.74, *SD* = 2.81). However, search performance with high-threat pictures (*M* = 19.35, *SD* = 3.61) did not differ from performance with the other two categories of background stimuli.

4.2.4 Discussion

Our main goal was to compare evolutionarily ancient and modern threatening stimuli, whilst systematically varying their arousal level, represented in the case by threat level. Within each threat category, the images of snakes and guns were rated similarly threatening and differed only with respect to arousal, as intended. Our results show that level of arousal did influence visual search performance; medium-arousal (low-threat) stimuli resulted in worse performance than less and more arousing background stimuli (no-threat and high-threat pictures, respectively). In our view, this account is consistent with the results of Experiment 1.

4.3 Experiment 3 – Validating the counting task and previous results

4.3.1 Aims and hypotheses

Finally, in the third experiment, we validated our results by replicating them whilst controlling for variance in low-level visual features and using a touchscreen monitor.

4.3.2 Method

4.3.2.1 Participants

Forty-one university students (19 men; 22 women) took part in the experiment voluntarily. None of them had participated in the number matrix pilot study or in the earlier experiments. The mean age of the sample was 21.95 years (*SD* = 2.33).

4.3.2.2 Visual display

Pictures were taken from IAPS and the Nencki Affective Picture System (NAPS; Marchewka, Żurawski, Jednoróg, & Grabowska, 2014)), based on ratings of valence and arousal provided by the two databases. Moreover, after completing the visual search task the participants in this experiment rated the valence, arousal, and threat levels of the pictures using nine-point Likert scales. As expected, the arousal ratings were very similar to the threat level ratings. We again used the matrix generator programme to create the matrices for this experiment.

To avoid the possible confounding effects of uncontrolled variance in low-level visual properties, we used the Spectrum, Histogram, and Intensity Normalisation and Equalisation (SHINE) toolbox (Willenbockel et al., 2010) written with MATLAB to adjust the images to ensure that they were equivalent with respect to these low-level properties. We then calculated image complexity for all the pictures, to enable us to control for the possible confounding effects of variance in visual complexity (Donderi & McFadden, 2005; Forsythe et al., 2011).

4.3.2.3 Procedure

The procedure was the same as in Experiment 1 and 2.

4.3.3 Results

We used MANOVA to analyse the data, with content (object; animal) and threat level (none; low; high) as independent variables. In confirmation of our previous results in Experiment 1 and 2 we once again observed a main effect of threat level ($F(2,80) = 5.54$, $p < .01$, $\eta_p^2 = .12$). There was no main effect of content and no interaction between content and threat level (*F*s < 1, $p > .1$). Pairwise comparisons using the Bonferroni correction revealed that low-threat pictures elicited worse visual search performance (*M* = 18.38, *SD* = 3.98) than both high-threat (*M* = 19.31, *SD* = 3.79) and no-threat (*M* = 19.31, *SD* = 3.79) pictures.

4.3.4 Discussion

Our results replicated those of Experiments 1 and 2. It seems that threatening stimuli do have an effect on perception and attention; they draw attention away from a task. We thus emphasise the importance of the other distractor stimulus variable, namely, arousal level. Arousal also influences visual search performance: a higher level of arousal compensates for the decrement in performance produced by negatively valenced distractors. We claim that negative, threatening background images are more effective in distracting attention from the separate cognitive task than non-threatening background images. Hence presentation of low-threat, medium arousal cues impaired visual search performance. However, as the threat level of distractor stimuli increases, arousal increases and this speed up the cognitive system, so that participants search more quickly when the background consists of a high-threat image and perform as well as when the background consists of a non-threatening image.

4.4 General Discussion

We have presented a new visual search paradigm that could prove a good alternative to the classical odd-one-out task. First, we showed that our method is capable of measuring the impact of emotions on cognitive processing; focusing on threatening cues. After this, our main aim was to elucidate the factors driving attentional processing of threatening, negative pictures. Does evolutionary history matter the most, as previous research suggests, or are other factors also important? In summary, we conclude that neither valence nor arousal is sufficient to account for the effects of emotionally charged stimuli on cognitive performance; both must be taken into account. In three experiments, we showed that arousal has a distinctive role in this effect, and therefore, cannot be neglected when designing visual search experiments. Negative stimuli can have an energising, triggering effect that can contribute to differences in behavioural responses. Highly arousing events can have a direct impact on response preparedness, most likely through activation of the autonomic nervous system. More work is needed in the future to address this issue.

5. FINAL CONCLUSIONS

During the course of three studies, and nine experiments in total, we introduced methodological innovations such that new paradigms, taking into possibly confounding factors (e.g. arousal level) and low-level visual feature controlling processes. Using various paradigms also allow us to draw conclusions that are not affected by methodological issues and specificities, and, thus are more generalizable. See Table 1 for an overview of the main results.

Table 1 – An overview of the results of experiments presented in the dissertation

Study nr.	Experiment Nr.	Paradigm	Main result
Study 1	Experiment 1	Classical visual search task	Modern threatening cues are found faster compared to evolutionary relevant ones only at high arousal level
	Experiment 2		Firemen did not differ from young adults despite age differences
	Experiment 3		Detection of evolutionary relevant threatening stimulus is based on general features, while the detection of modern one is based on specific features.
Study 2	Experiment 1	New visual search task	Pilot study - Introducing a novel paradigm
	Experiment 2		The best representatives of evolutionary and modern threatening stimuli are found equally faster than neutral targets
	Experiment 3		Threat superiority effect is specific to some advantaged stimuli
Study 3	Experiment 1	Number matrices	Negative valence at medium arousal level decreased search performance
	Experiment 2		Negative arousal decreases search performance while higher levels of arousal compensate for this effect
	Experiment 3		Repeated the results of Experiment 2 using a touch-screen monitor

5.1 New theses of the dissertation

I. The important effect of emotional arousal in cognitive tasks

First, we have shown that the arousal level of the emotionally charged stimuli is as important as its valence. In a VST (see Study 1) arousal level differentiates between threatening targets of different origin; while in a visual performance task (see Study 2) higher levels of arousal compensates for the effects of negative valence.

II. Not evolutionary origin, but possibly other motivational and individual factors are responsible for the advantaged processing of some stimuli in visual processing

Second, it seems that some threatening cues are more advantaged than others (see Study 3), however, not based on evolutionary relevance, but rather motivational and individual factors. A large portion of the studies presented here relied on the most often used exemplar of the evolutionary and modern threatening categories (snake and gun, respectively). These stimuli might be the most often used because they represent threat the most. Thus, other stimuli that are still threatening but possibly to a lesser extent should receive more attention in the future.

III. Methodological innovation

Finally, the fact that these results were achieved using three different paradigms, two of which are coined here add to the validity of these claims. Thus, we hope that the methods and results presented here might add to the better understanding of the phenomenon in question. Future studies could use one of our novel paradigms, based on their goals. In Study 2 we provide a good alternative to the classical VST to measure the time needed to find a cue. In Study 3 we showed that the influence of different stimuli on cognitive performance could also be assessed.

References

Blanchette, I. (2006). Snakes, spiders, guns, and syringes: How specific are evolutionary constraints on the detection of threatening stimuli? *Quarterly Journal of Experimental Psychology*, *59*(8), 1484–1504. https://doi.org/10.1080/02724980543000204

Brown, C., El-Deredy, W., & Blanchette, I. (2010). Attentional modulation of visual-evoked potentials by threat: Investigating the effect of evolutionary relevance. *Brain and Cognition*, *74*(3), 281–287. https://doi.org/10.1016/J.BANDC.2010.08.008

Coelho, C. M., & Purkis, H. (2009). The origins of specific phobias: Influential theories and current perspectives. *Review of General Psychology*, *13*(4), 335–348. https://doi.org/10.1037/a0017759

Davey, G. C. L. (1995). Preparedness and phobias: Specific evolved associations or a generalized expectancy bias? *Behavioral and Brain Sciences*, *18*(02), 289. https://doi.org/10.1017/S0140525X00038498

Deák, A., Csenki, L., & Révész, G. (2010). Hungarian ratings for the International Affective Picture System (IAPS): A cross-cultural comparison. *Empirical Text and Culture Research*, *4*, 90–101.

Donderi, D. C., & McFadden, S. (2005). Compressed file length predicts search time and errors on visual displays. *Displays*, *26*(2), 71–78. https://doi.org/10.1016/J.DISPLA.2005.02.002

Forsythe, A., Nadal, M., Sheehy, N., Cela-Conde, C. J., & Sawey, M. (2011). Predicting beauty: Fractal dimension and visual complexity in art. *British Journal of Psychology*, *102*(1), 49–70. https://doi.org/10.1348/000712610X498958

Fox, E., Griggs, L., & Mouchlianitis, E. (2007). The Detection of Fear-Relevant Stimuli: Are Guns Noticed as Quickly as Snakes? *Emotion*, *7*(4), 691–696. https://doi.org/10.1037/1528-3542.7.4.691

Gao, X., LoBue, V., Irving, J., & Harvey, T. (2017). The effect of spatial frequency information and visual similarity in threat detection. *Cognition and Emotion*, *31*(5), 912–922. https://doi.org/10.1080/02699931.2016.1180280

Hemmatjo, R., Motamedzade, M., Aliabadi, M., Kalatpour, O., & Farhadian, M. (2017). The effect of practical cooling strategies on physiological response and cognitive function during simulated firefighting tasks. *Health Promotion Perspectives*, *7*(2), 66–73. https://doi.org/10.15171/hpp.2017.13

Isbister, G. K., & White, J. (2004). Clinical consequences of spider bites: recent advances in our understanding. *Toxicon*, *43*(5), 477–492. https://doi.org/10.1016/J.TOXICON.2004.02.002

Lang, P., Bradley, M., & Cuthbert, B. N. (1997). International Affective Picture System (IAPS):

Technical Manual and Affective Ratings. *NIMH Center for the Study of Emotion and Attention*, 39–58. https://doi.org/10.1027/0269-8803/a000147

Marchewka, A., Żurawski, Ł., Jednoróg, K., & Grabowska, A. (2014). The Nencki Affective Picture System (NAPS): Introduction to a novel, standardized, wide-range, high-quality, realistic picture database. *Behavior Research Methods, 46*(2), 596–610. https://doi.org/10.3758/s13428-013-0379-1

Nosofsky, R. M., & Johansen, M. K. (2000). Exemplar-based accounts of "multiple-system" phenomena in perceptual categorization. *Psychonomic Bulletin & Review, 7*(3), 375–402. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11082849

Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion Drives Attention: Detecting the Snake in the Grass. *Journal of Experimental Psychology: General, 130*(3), 466–478. https://doi.org/10.1037/AXJ96-3445.130.3.466

Öhman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: toward an evolved module of fear and fear learning. *Psychological Review, 108*(3), 483–522. Retrieved from doi.org/10.1037//0033-295X.108.3.483

Öhman, A., & Mineka, S. (2003). The Malicious Serpent. *Current Directions in Psychological Science, 12*(1), 5–9. https://doi.org/10.1111/1467-8721.01211

Osherson, D. N., & Smith, E. E. (1981). On the adequacy of prototype theory as a theory of concepts. *Cognition, 9*(1), 35–58. https://doi.org/10.1016/0010-0277(81)90013-5

Pataki, F. (2002). Az „affektív forradalom" dilemmái. *Magyar Pszichológiai Szemle, 57*(4), 605–631. https://doi.org/10.1556/MPSzle.57.2002.4.5

Pessoa, L. (2013). The cognitive-emotional brain: From interactions to integration. *The Cognitive-Emotional Brain: From Interactions to Integration.* https://doi.org/10.1073/pnas.0703993104

Purkis, H. M., & Lipp, O. V. (2007). Automatic attention does not equal automatic fear: Preferential attention without implicit valence. *Emotion, 7*(2), 314–323. https://doi.org/10.1037/1528-3542.7.2.314

Quinlan, P. T. (2013). The visual detection of threat: A cautionary tale. *Psychonomic Bulletin & Review, 20*(6), 1080–1101. https://doi.org/10.3758/s13423-013-0421-4

Quinlan, P. T., Yue, Y., & Cohen, D. J. (2017). The processing of images of biological threats in visual short-term memory. *Proceedings. Biological Sciences*, *284*(1861), 20171283. https://doi.org/10.1098/rspb.2017.1283

Sander, D., Grafman, J., & Zalla, T. (2003). The Human Amygdala: An Evolved System for Relevance Detection. *Reviews in the Neurosciences, 14*(4), 303–316. https://doi.org/10.1515/REVNEURO.2003.14.4.303

Sander, D., Grandjean, D., & Scherer, K. R. (2005). A systems approach to appraisal mechanisms in emotion. *Neural Networks*, *18*(4), 317–352. https://doi.org/10.1016/J.NEUNET.2005.03.001

Storbeck, J., & Clore, G. L. (2007). On the interdependence of cognition and emotion. *Cognition & Emotion*, *21*(6), 1212–1237. https://doi.org/10.1080/02699930701438020

Subra, B., Muller, D., Fourgassie, L., Chauvin, A., & Alexopoulos, T. (2017). Of guns and snakes: testing a modern threat superiority effect. *Cognition and Emotion*, 1–11. https://doi.org/10.1080/02699931.2017.1284044

Willenbockel, V., Sadr, J., Fiset, D., Horne, G. O., Gosselin, F., & Tanaka, J. W. (2010). Controlling low-level image properties: The SHINE toolbox. *Behavior Research Methods*, *42*(3), 671–684. https://doi.org/10.3758/BRM.42.3.671

Yue, Y., & Quinlan, P. T. (2015). Appraising the role of visual threat in speeded detection and classification tasks. *Frontiers in Psychology*, *6,* 755. https://doi.org/10.3389/fpsyg.2015.00755

List of own publications

Publications in the topic of the dissertation

Papers and book chapters

Zsidó, A. N., Deák, A., & Bernáth, L. (2018) Is a snake scarier than a gun? The ontogenetic - phylogenetic dispute from a new perspective: the role of arousal. *Emotion,* Available Online **IF: 3.251**

Zsidó, A. N., Losonci, A., Stecina, T. D., Arató, A., Deák, A., & Bernáth, L. (2018) Investigating evolutionary constraints on the detection of threatening stimuli in children – General vs. specific feature detection depends on evolutionary relevance. *Acta Psychologica,* 185, 166-171 **IF: 2.031**

Zsido, A. N. (2017). The spider and the snake – A psychometric study of two phobias and insights from the Hungarian validation. *Psychiatry Research*, *257*, 61–66. https://doi.org/10.1016/j.psychres.2017.07.024 **IF: 2.528**

Zsido, A. N., Arato, N., Inhof, O., Janszky, J., & Darnai, G. (2018). Short versions of two specific phobia measures: The snake and the spider questionnaires. *Journal of Anxiety Disorders*, *54*. https://doi.org/10.1016/j.janxdis.2017.12.002 **IF: 3.105**

Zsido, A. N., Bernath, L., Labadi, B., & Deak, A. (2018). Count on arousal: introducing a new method for investigating the effects of emotional valence and arousal on visual search performance. *Psychological Research*. https://doi.org/10.1007/s00426-018-0974-y **IF: 3.119**

Arató Á., Stecina D.T., Losonci A., **Zsidó A.** (2017). Fenyegető ingerek észlelése mindennapi és negatív helyzetekben. *Impulzus,* 4, 1-16.

Zsidó, A., Deák, A. & Bernáth, L. (2017). Fenyegető ingerek hatása a kognitív teljesítményre: áttekintés. *Magyar Pszichológiai Szemle,* 72(3), pp. 381–399

Zsidó, A. (2017). Meglátni és megijedni – Az állatfóbia fejlődéslélektani gyökerei kognitív-evolúciós szemmel. In Bóna, A., Lénárd, K., Pohárnok, M. (szerk.) *Bontakozó jelentés – Tanulmányok a 60 éves Péley Bernadette köszöntésére*. Oriold, Budapest

Zsidó, A. (2017). Mitől félnek a tűzoltók? – Egy kognitív vizuális kereséses vizsgálat a félelem-detekció nyomában. In Nagy, N., Tóbi, I. (szerk.) *Pro Scientia Aranyérmesek Konferenciakötet*. Pro Scientia Aranyérmesek Társasága Egyesület, Budapest

Zsidó, A., Deák, A., & Bernáth, L. (2013). Individuális különbségek az affektív ingerek hatásában egy vizuális keresési feladat során. In: Szamonek Vera (szerk.). *11. Országos Interdiszciplináris Grastyán konferencia előadásai.* PTE Grastyán Endre Szakkollégium, Pécs

Zsidó, A., Deák, A., & Bernáth, L. (2012). A vizuálisan bemutatott affektív ingerek befolyásolják a keresési teljesítményt. In: Szamonek Vera (szerk.). *10. Országos Interdiszciplináris Grastyán konferencia előadásai.* PTE Grastyán Endre Szakkollégium, Pécs

Conference abstracts

Zsidó, A. (2018). *On the track of threat detection*. PSZIESZTA - Pécsi Pszichológus Napok. Pécs, Hungary

Zsidó, A., Deák, A., Lábadi, B., Darnai, G., Inhóf, O., & Bernáth, L. (2018). *Can a modern threat be processed similarly to an evolutionary relevant? - Introducing a novel paradigm to study visual search.* 13th European Human Behaviour and Evolution Association Annual Conference. Pécs, Hungary

Zsidó, A., Inhóf, O., Darnai, G., Csathó, Á., Matúz, A., Lábadi, B., & Bernáth, L. (2017). *A direct comparison of evolutionary-relevant and modern stimuli in visual search – Does fear have an advantage at all?*. 60th Conference of Experimental Psychologists – TeaP, Marburg, Germany

Ihász, V., **Zsidó, A.** (2018). *Finding an emotional face in the kindergarten*. Budapest CEU Conference on Cognitive Development, Budapest, Hungary

Zsidó, A., & Bernáth, L. (2017). *Érzelmi dimenziók hatása a kognitív teljesítményre – Számolnunk kell az arousallel* A Magyar Pszichológiai Társaság XXVI. Országos Tudományos Nagygyűlése, Szeged, Hungary

Stecina, D. T., Losonci, A., Arató, Á., **Zsidó, A.** (2017). *Jobb félni, mint megijedni – fenyegető ingerek észlelése mindennapi és negatív helyzetekben*. A Magyar Pszichológiai Társaság XXVI. Országos Tudományos Nagygyűlése, Szeged, Hungary

Zsidó, A., Arató, A., Stecina, D. T., Losonci, A., & Bernáth, L. (2017). *Guns on the streets and snakes in the grass – The role of the context in visual threat detection*. 59th Conference of Experimental Psychologists – TeaP, Drezden, Germany

Zsidó, A. (2016). *Mitől félnek a tűzoltók? Egy kognitív vizuális kereséses vizsgálat a félelem-detekció nyomában*. Pro Scientia Aranyérmesek XIII. Konferenciája, Pécs, Hungary

Zsidó, A., Deák, A. & Bernáth, L. (2016*). The role of evolutionary origin in visual search: Are we using the right method?*. 2nd Pécs Workshop on Cognitive and Developmental Psychology. Pécs, Hungary

Zsidó, A., Bernáth, L. & Deák, A. (2016*). Investigating the effects of fear on a special population - A pilot study*. 12nd Alps-Adria Psychology Conference. Rijeka, Croatia

Zsidó, A., Stecina, D., Arato, A., Losonci, A. & Bernáth, L. (2016*). Detecting fear appositely: The role of the context in a visual search paradigm*. British Association for Cognitive Neuroscience Conference. Budapest, Hungary

Zsidó, A., Deák, A. & Bernáth, L. (2016*). Can we protect ourselves? Studying fear acquisition with a visual search paradigm*. Global Awareness Society International 25rd Annual Conference. Budapest, Hungary

Zsidó, A., Deák, A. & Bernáth, L. (2016). *Melyik a kakukktojás: A kígyó vagy a pisztoly?*. A Magyar Pszichológiai Társaság XXV. Országos Tudományos Nagygyűlése

Zsidó, A., Deák, A., & Bernáth, L. (2015). *An Evolutionary and Individualistic Perspective on Visual Search Performance*. 10th European Human Behaviour and Evolution Association Annual Conference. Helsinki, Finland

Zsidó, A., Deák, A., & Bernáth, L. (2014). *Evolutionary origin or arousal modulates visual search?* 11th Alps-Adria Psychology Conference. Pécs, Hungary

Zsidó, A., Deák, A., & Bernáth, L. (2014). *How Does Evolutionary Origin and Arousal Modulate Visual Search in the Mirror Of Anxiety?* Global Awareness Society International 23rd Annual Conference. Montego Bay, Jamaica

Zsidó, A., Deák, A., & Bernáth, L. (2014). *Érzelmi töltetű képek hatása a keresési teljesítményre a kötődési stílus és a disszociativitás tükrében*. XII. Grastyán Endre Országos Interdiszciplináris Konferencia

Zsidó, A. (2013). *Onto- és filogenetikus eredetű félelmeink*. Tudományos Ismeretterjesztő Konferencia A Magyar Tudomány Ünnepe Alkalmából

Zsidó, A., Deák A., & Bernáth L. (2013). *Individuális különbségek az affektív ingerek hatásában egy vizuális keresési feladat során*. XI. Grastyán Endre Országos Interdiszciplináris Konferencia

Zsidó, A. (2013). *Hogyan befolyásolhatják az érzelmek a kognitív teljesítményt?* Pécsi Pszichológus Napok Országos Diákszekció

Deák, A., **Zsidó, A**., & Bernáth, L. (2013). *Miben hasonlít a kígyó és a pisztoly? A valencia és arousal hatása a vizuális keresésre*. A Magyar Pszichológiai Társaság XXII. Országos Tudományos Nagygyűlése

Deák, A., **Zsidó, A**., & Bernáth, L. (2012). *Modelling an emergency situation: How do emotional valence and arousal affect visual search performance*. 10th Alps-Adria Psychology Conference. Lignano Sabbiadoro, Italy

Zsidó, A, Deák, A., & Bernáth, L. (2012). *A vizuálisan bemutatott affektív ingerek befolyásolják a keresési teljesítményt*. X. Grastyán Endre Országos Interdiszciplináris Konferencia

Zsidó, A. (2012). *Vajon leírható a vészhelyzeti reakció?* Pécsi Pszichológus Napok Országos Diákszekció

Publications <u>not</u> in the topic of the dissertation

Papers and book chapters

Czibor, A., Szabo, Z. P., Jones, D. N., **Zsido, A. N**., Paal, T., Szijjarto, L., ... & Bereczkei, T. (2017). Male and female face of Machiavellianism: Opportunism or anxiety?. *Personality and Individual Differences*, 117, 221-229. **IF: 2.005**

Zsidó, A. (2015). A vészhelyzeti viselkedés személyiséglélektani korrelátumai – első lépések egy új mérőeszköz kidolgozása felé. In. Böhm, G., & Fedeles, T. (szerk.) *Specimina Operum Iuvenum 3*. PTE BTK KTDT, Pécs

Zsidó, A., Deák, A., & Bernáth, L. (2014). Affektív ingerek hatása a kognitív teljesítményre a kötődési stílus és a disszociativitás tükrében. In. Rab Virág (szerk.). *12. Országos Interdiszciplináris Grastyán konferencia előadásai.* PTE Grastyán Endre Szakkollégium, Pécs

Conference abstracts

Zsidó, A., Darnai, G., Inhóf, O, Perlaki, G., Orsi, G., Nagy, Sz., Lábadi, B., Lénárd, K., Arató, N., Kovács, N., Dóczi, T., Janszky, J. (2018). *A vonás impulzivitás és kéregvastagsága összefüggése eltér fiatal felnőtt internetfüggők és egészséges kontroll populációban*. A Magyar Pszichológiai Társaság XXVI. Országos Tudományos Nagygyűlése, Budapest, Hungary

Budai, T., Kiss, Sz., Lénárd, K., **Zsidó, A.** (2018). *A Tudatelméleti Skála magyar adaptációja.* A Magyar Pszichológiai Társaság XXVI. Országos Tudományos Nagygyűlése, Budapest, Hungary

Arató, N., **Zsidó, A.**, Lábadi, B., Lénád, K. (2018). *Az online bántalmazás pszichológiája: A szocio-emocionális készségek szerepe.* A Magyar Pszichológiai Társaság XXVI. Országos Tudományos Nagygyűlése, Budapest, Hungary

Inhóf, O., **Zsidó, A.**, Darnai, G., Lábadi, B., & Révész, Gy. (2018). *The effect of auditory stimuli in visual search task.* 60th Conference of Experimental Psychologists – TeaP, Marburg, Germany

Darnai, G., Lábadi, B., **Zsidó, A.**, Inhóf, O., Orsi, G., Perlaki, G., Nagy, Sz., & Janszky, J. (2018). *Cognition and inhibitory processes in internet addiction: Stroop-related fMRI study*. 60th Conference of Experimental Psychologists – TeaP, Marburg, Germany

Budai, T., Lénárd, K., **Zsidó, A.**, & Kiss, Sz. (2018). Theory of Mind Scale - the Hungarian adaptation. Budapest CEU Conference on Cognitive Development, Budapest, Hungary

Perlaki, G., Darnai, G., Orsi, G., Szente, A., Csaba, G., **Zsido, A.**, Inhof, O., Labadi, B., Nagy, Sz., Horvath, R., Janszky, J. (2017). *Do addictions influence language lateralization?*. Neuroimaging Workshop, Szeged, Hungary

Darnai, G., Perlaki, G., Orsi, G., Szente, A., Csaba, G., **Zsido, A.**, Inhof, O., Labadi, B., Nagy, Sz., Horvath, R., Janszky, J. (2017). *Is internet use risky? Altered default mode network in problematic internet users*. Neuroimaging Workshop, Szeged, Hungary

Zsidó, A. (2017). *Az internetfüggőség hatása a téri-vizuális figyelmi teljesítményre – Ok vagy okozat?* A Magyar Pszichológiai Társaság XXVI. Országos Tudományos Nagygyűlése, Szeged, Hungary

Arató, N., Lábadi, B., Lénárd, K., **Zsidó, A.** (2017). *A Cyber Victim and Bullying Scale magyarországi adaptálása*. A Magyar Pszichológiai Társaság XXVI. Országos Tudományos Nagygyűlése, Szeged, Hungary

Darnai, G., **Zsidó, A.**, Inhóf, O., Kohn, E., Neidert, L., Simon, E., Janszky, J., Lábadi B. (2017). *Agyunkra mehet az internet?: problémás internethasználat és a jutalmazó rendszer*. A Magyar Pszichológiai Társaság XXVI. Országos Tudományos Nagygyűlése, Szeged, Hungary

Inhóf, O., Darnai, G., **Zsidó, A.**, Koltai, E., Simon, E., Neidert, L., & Lábadi, B. (2017) *The role of interhemispheric cooperation in the modulation of spatial attention during multitasking*. 59th Conference of Experimental Psychologists – TeaP, Drezden, Germany

Zsidó, A., Deák, A. & Bernáth, L. (2016). *Remember not to forget emotional priming*. Cognitive and Neural Mechanisms of Human Memory Conference. Cluj-Napoca, Romania

Zsidó, A. (2015). *Hosszú-távú érzelmi priming hatása a kognitív figyelmi folyamatokra*. II. Grastyán Endre Minősítő Konferencia

Zsidó, A. (2014). *The role of motivation in the szinapszis program and psychologycal models behind talent*. Global Awareness Society International Talent Workshop

Zsidó, A. (2014). *Nagyobb agy, magasabb IQ?* Pécsi Pszichológus Napok Országos Diákszekció

Zsidó, A. (2014). *Szinapszis mentorprogram*. III. Interdiszciplináris Doktorandusz Konferencia

Zsidó, A. (2013). *Predicting the behavior in an emergency situation with a questionnaire*. X. János Szentágothai Transdisciplinary Conference. Pécs, Hungary