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Anxiety Can Influence Analogy-Making Both Positively and Negatively Depending on the Complexity of the Mapping Task

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Abstract

In attempt to resolve the controversial issue of the influence of the anxiety state on analogy-making this paper presents a replication of the original Tohill and Holyoak study extending it with a new factor – the complexity of the mapping. It turns out that the anxiety influence interacts with the complexity of the mapping task. This has certain implications for the models of analogy and for the further study of the role anxiety plays in analogy-making.

Keywords: analogy; emotion, state anxiety, complexity.

How Anxiety Changes Analogical Mapping

The chronologically first studies that focus on analogies under anxiety, suggest that analogical performance drops significantly when the state anxiety is heightened. Leon and Revelle (1985) manipulated anxiety via time pressure. They found that people are more accurate under low time-pressure, but unfortunately, as Tohill and Holyoak (2000) have argued, these results could also be interpreted as a speed/accuracy trade-off. The negative correlation between anxiety and accuracy reported for the low time-pressure group is also inconclusive with respect to the possible causal link between anxiety and analogies.

Tohill and Holyoak (2000), however, also found decline in identification of the relational mappings under an induced state anxiety in a well-controlled study (Exp2). Prior to the analogy-making session, they manipulated the state anxiety via a serial subtraction task with negative feedback. The procedure turned out to differentiate successfully the anxiety of the two groups, measured with the State-Trait Anxiety Inventory (STAI) (Spielberger, Gorsuch, & Lushene, 1970). Analogy performance was measured by a cross-mapping visual task. Participants saw two pictures on the screen for 15 seconds, then one object in the first picture was pointed at and they were instructed to indicate either which object from the second picture "goes with" the pointed one (Exp1), or to indicate the object from the second picture that "relationally matches" the pointed one (Exp2). The task is difficult because the target object has always two plausible matches – one at the level of object similarity (i.e., the same or an extremely similar object present in the second picture) and another at the level of relational similarity (i.e., a superficially distinct object that plays an analogous role in the second picture). Less relational responses (Exp1) and less accuracy of identifying the relational match (Exp2) were found for participants from the high state-anxiety group. The decline in relational reasoning was explained by the Processing Efficiency Theory of Eysenck and Calvo (1992). According to that theory and its successor – the Attentional Control Theory (Eysenck, Deraksan, Santos & Calvo, 2007), attention of highly anxious individuals is distracted by the anxiety related thoughts. Thus, instead of focusing on the main task, anxious individuals ruminate about the threatening situation, the stimuli or the potential failure. Hence, as Holyoak (2012) has pointed out, anxiety seems to place individuals in a dual task situation that definitely reduces the available working memory resources and in turn, changes analogical mapping from relational (based on common relations) to superficial mode (based on common features). Besides, it was argued that both the capability to integrate multiple relations and to inhibit distracting information during analogy-making depend crucially on the available resources (Cho, Holyoak, & Cannon, 2007; Krawczyk, Morrison, Viskontas, Holyoak, Chow, Mendez, Miller, & Knowlton, 2008; Sweis, Bharani, & Morrison, 2012; Viskontas, Morrison, Holyoak, Hummel, & Knowlton, 2004). To sum up, it seems reasonable to consider that state anxiety reduces the capability of an individual to integrate the relevant relations and to inhibit the irrelevant ones, which are directly connected to analogical mapping.

However, analogy-making involves not only choosing among various potential relational matches, but is a much more complicated process that integrates perception and encoding of the existing relations in the environment (among the many possible relations some are relevant for the analogy, others are not), building hypotheses about possible pairs of corresponding relations, and choosing among these hypotheses which are forming the most consistent mapping.

Anxiety could have an influence on all these processes, including the perception of relations. However, it was shown that threatening stimuli prompt participants to search faster for both threatening and non-threatening stimuli (Becker, 2009). Likewise, Phelps, Ling, and Carrasco (2006) reported that contrast sensitivity increases after a presentation of a fearful face. In addition, Pacheco-Unguetti, Acosta, Callejas, and Lupianez (2010) reported neuroimaging data suggesting that state and trait anxiety modulate differentially the work of the three attentional networks presumed by Posner and Petersen (1990) and Posner, Rueda, and Kanske (2007). State anxiety was associated with overfunctioning of the alerting and the orienting attentional networks, while trait anxiety with insufficiency of the executive control network. In other words, state anxiety reinforces bottom-up processing (i.e., perception and selection of relevant information), and trait-anxiety hampers the top-down control (i.e., voluntary action control and conflict resolution). That is why Hristova and Kokinov (2011) studied the influence of anxiety on the perception of relations. They reported that people in heightened state anxiety are superior in encoding of relations between superficially dissimilar geometric figures: they were both faster and significantly more accurate than participants in the control group in recognizing identical relations between two sets of figures. Therefore, it was argued that the superior encoding of relations under heightened state anxiety may improve, instead of impeding analogical mapping. Indeed, some research supports this hypothesis.

Richert, Whitehouse, and Stewart (2005) showed that religious rituals, performed in high anxiety states, lead to a higher percentage of generated reflections (including ones, based on analogies) and that percentage increased significantly over a one-month time period. They argued that rarely performed religious rituals, accompanied by high physiological arousal become the focus of conscious rumination and in that way advantage the drawing of more and deeper analogies between the current anxious situation and the individual personal memory. This leads to a better memory for a given ritual and binds the religious ideas to personal experience. The reported results, however, were inconclusive, since arousal was manipulated through the ritual itself (high arousal and low arousal rituals) and analogies were only part of the interpretations that were measured.

Later, Feldman, Hristova, and Kokinov (2010) demonstrated that participants in high state anxiety were more prone to relational matches between superficially dissimilar stimuli instead of superficial matches between structurally dissimilar stimuli in a match-to-sample task. Participants were shown a sample set that consists of three geometric figures and were asked to indicate which of the two target sets of figures is more similar to the sample one. High state anxiety participants were significantly more likely to indicate the relational target instead of the superficially similar one, for a comparable amount of time (i.e. the difference between RTs in the anxiety and the control group was insignificant). Thus, surprisingly, it was demonstrated that induced state anxiety can support analogies in a situation quite similar to the one used in the first experiment of Tohill and Holyoak (2000). Both experiments require a choice between superficially similar and relationally similar options. The authors (Feldman et al., 2010) discussed the controversy between the data and suggested that it can be potentially explained by the difference in the experimental procedures that possibly eliminated the benefits of the superior encoding (if any) for the anxiety group in the Tohill and Holyoak's case: maybe the 15 sec stimulus presentation used in the Tohill and Holyoak's study (Tohill & Holyoak, 2000), but not in theirs[1], had restricted the effect of the superior encoding of relations that was discussed above.

Alternatively, however, as Feldman et al. (2010) discussed, the same empirical inconsistency may be due to the difference in either the intensity of the induced state anxiety or the difficulty of the analogical tasks used in either or both studies. That particular explanation corresponds to the well-known Yerkes–Dodson Law (Yerkes & Dodson, 1908) that postulates a nonlinear inverted U-shaped relationship between stimulus strength and the rapidity of habit formation for tasks varying in discrimination difficulties. Taking into account the fact that later, it was largely assumed that the same U-shaped relationship is also valid when describing the relation between (emotional) arousal and performance (Broadhurst, 1957), and that arousal is largely recognized as the physiological component of any emotional state, including anxiety, it is reasonable to assume that the studies of Tohill and Holyoak (2000) and Feldman et al. (2010) could have been run with anxiety states that differ in intensity. Unfortunately, the two studies differ in both the procedure used for anxiety induction[2] and the manipulation-check instrument[3], so it was not possible to reject that explanation at that point. Moreover, those studies used different stimuli[4] and tasks[5]. Hence, if one of the tasks was more difficult than the other,

[1] Participants in the study of Feldman et al. (2010) were prompted to give an answer immediately after the presentation of the stimulus.

[2] Tohill and Holyoak (2000) used a serial subtraction task, while Feldman et al. (2010) – a "public speech" procedure.

[3] STAI for Tohill and Holyoak (2000) and a self-assesment 5-point scale for the Feldman et al. (2010).

[4] The Feldman et al. (2010) study used geometric figures and the relations between them, while the Tohil and Holyoak (2000) study, used much more complex everyday situations, depicted in two pictures, which usually involved more than 3 actors and a number of diverse relations between them.

[5] Match-to-sample task (Feldman et al. (2010)) - one sample and two distinct targets (one superficially similar and one relationally similar) vs. a cross-mapping task, where participants should choose which option in the bottom picture "goes with" the object, pointed from the experimenter. Both the target object and the options were embedded in complex relational structures. The number of options varied between 3 and 6 alternatives for answer, etc.

the respective optimal levels of arousal will also differ, since the more difficult the task is, the lower the respective level of optimal arousal is.

Thus the goal of the present study is to replicate Experiment 2 of Tohill and Holyoak (2000), while explicitly varying the complexity of the task. And we expect interaction between the anxiety state (low and high anxiety) and the complexity of the analogy task. The complexity here is operationalized by the number of potential hypotheses that could participate in the competition for the best match. This is manipulated in the task by the number of alternatives offered among which the answer is to be chosen.

Experiment: Many vs. Small Number of Alternatives

This experiment varies within-subject the number of the suggested alternatives for the answer. This seems an easiest way to manipulate the complexity of the task without changing the stimuli themselves: choosing between two alternatives is easier than choosing between four.

Method

Design

We used a 2x2 mixed factorial design with two levels of state anxiety (anxiety and control) and two options for complexity of the task (choosing between 2 answers vs. choosing between 4 answers). The level of state anxiety was varied between-subject by serial subtraction task, described thoroughly in the procedure section below. The complexity of the task was operationalized as the number of possible alternatives for the answer and it was varied within-subject. Half of the trials for each participant required a choice of answer between 2 alternatives, the other half between 4 alternatives. The dependent variables of this study were the accuracy, defined as correct identification of the relational match, and the response time.

Between-subject counterbalancing: Stimuli were between-subject counterbalanced with the number of alternatives (i.e. 2 or 4 alternatives for answer). In addition, the letters of the available alternatives for answer (i.e. A, B, C or D) were also balanced across stimuli and participants.

Stimuli

The stimuli were 14 analogical picture-pairs with cross-mapping (i.e., they allow both an attribute mapping of a key object and a relational one). Nine of those pairs were redrawn from the original stimuli used in the study of Tohill and Holyoak (2000)[6]. Taken as a whole, the pictures look quite different from their originals, but they consist of the same relations and preserve the cross-mapping structure of their originals. We add 5 new picture-pairs that also have a cross-mapping structure. So, overall we used 14 black and white picture-pairs in our study. For all of them, the key object in the top picture (i.e. the circled one) corresponds to two objects in the bottom picture in the same picture-pair: in picture-pair 1 in Figure 1 the fisherman in the picture corresponds to both the fisherman and the seagull in the bottom picture. The former correspondence is based on shared physical characteristics and that is why, it can be considered as a result from an attribute mapping, while the latter is based on shared relations (i.e. they both catch the fish) and hence it can be considered to be based on a relational mapping. Similarly, the circled girl in the top picture of pair 2 (Figure 1), maps both the girl and the teddy-bear in the bottom picture. The former mapping is an attribution one (i.e. the two girls possess similar physical characteristics), the latter is an relational one (i.e. they both receive an injection).

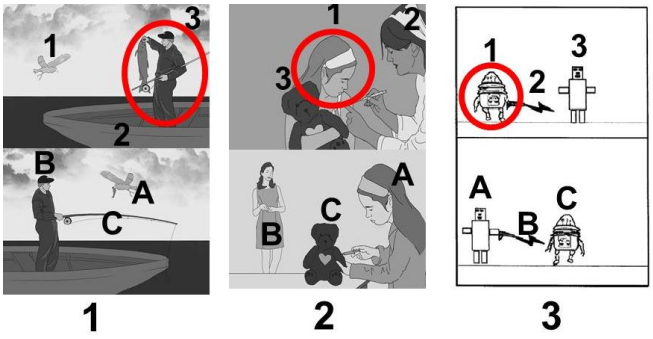


Figure 1: Examples of picture-pairs that contain cross-mapping. Picture-pair1 is a redrawing of one of the original drawings used in the Tohill and Holyoak study (2000). Picture-pair2 is an example of one of the new stimuli with cross-mapping created purposely for the current study. Picture-pair3 is the training picture-pair, used to explain the meaning of relational correspondence.

Procedure

Participants were tested individually in a soundproof cubicle. They were randomly assigned to the control or anxiety condition. All of them were informed that they would take part in a study on representation of numbers and they might be asked either to count backward or forward from a given number. They were told that the specific direction for each of them will be chosen randomly. However, since the counting procedure should be accomplished twice they were notified that we would asked them to take part in two short unrelated investigations in-between: the first one, connected to relational reasoning and the second one, connected to an on-going standardization of a questionnaire for a Bulgarian population.

Participants in the anxiety condition were asked to count aloud backward beginning at 1000, 970 or 950 in increment of 13. The starting point for each participant was randomly

[6] Seven of them were devised by Markman and Gentner (1993) for a study of structural alignment; two were created later and used in the experiments on how anxiety influences analogical mapping by Tohill and Holyoak (2000). Both research groups kindly provided their stimuli for our study. All original stimuli were drawn again, carefully preserving the key relations between the objects.

assigned. Two experimenters took part in the experiment: one of them corrected the mistakes, while the other one – measured the time and urged participants to count faster and faster, since the predetermined time of 45 seconds was about to expire. When the counting task was finished, one of the experimenters left the cubicle. Participants in the control condition were asked to count forward aloud beginning at 1 for 45 sec. They were instructed to count at a pace that relaxes them.

Both groups started the analogy-making task immediately after the counting. The procedure for stimuli presentation and the instruction given to the participants were analogous to those used by Tohill and Holyoak in Experiment 2 of their study (2000). Participants were told that they would be shoun picture-pairs one by one on the screen. Some of the objects in the top picture would be numbered and some of the objects in the bottom picture would be lettered. The two pictures will stay on the screen for 15 seconds before one of the numbered objects in the top picture will be circled in red. Their task is to indicate by pressing the respective button on the BBOX, which of the lettered objects from the bottom picture corresponds to the circled one from the top picture. They were trained to focus on the relations between objects with the robot example used by Tohill and Holyoak (2000) (Figure 1). Frist, the participants were asked to think and say, whether robot "A", "B" or "C" from the bottom picture is related analogously to the robot 1 from the top picture. Independent of the answer all participants received the same explanation: "Robot "1" corresponds to robot "A" because they took part in similar relations, i.e. they both are using weapons".

Then participants were instructed that some trials would require a choice between two alternatives, others between four alternatives. Finally, they were asked to indicate their answer as accurately and as fast as possible. If participants confirmed that they have understood the task and they have no questions concerning the experiment they move on to the target trails.

After the analogy-making task the participants filled out the Bulgarian adapted version of Spielberger's STAI (Щетински, Паспаланов, 1989). Then they count again forward or backward, depending on the condition and were not urged so frantically this time to count faster. In fact, the last counting was exclusively made to restore participant's mood after anxiety manipulation. Anxious participants were told that they have counted backward exceptionally well during their second turn. In addition, although we did not revealed the real hypothesis of the experiment, we told them that the counting task sometimes leads people to feel a little bit disturbed or tense, so if they feel in that way it may well be because of the task.

The whole experiment lasts between 15 and 20 minutes. The timing of events during the whole experiment is presented in Figure 3.

The experiment was double-blind: the experimenters knew that they should induce anxiety via the serial subtraction task and that we are looking for some differences in performance due to that anxiety. However they didn't know what kind of differences were expected between conditions.

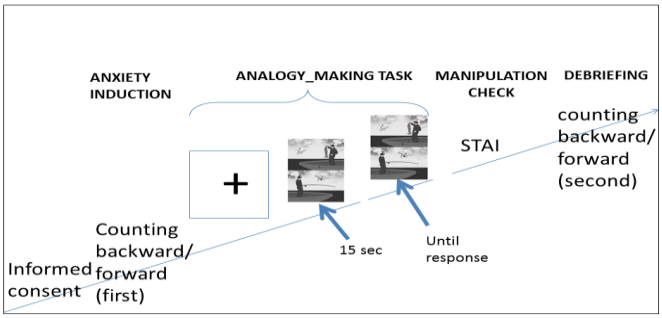


Figure 3: Stimulus displays and the timing of events.

Participants

90 (44 female and 46 male) volunteers took part in this experiment. All of them were students at New Bulgarian University from different university specialties. The mean age was 23.5 years ranging from 19 to 39 years. The control group consisted of 44 participants, the anxious group – of 46. The groups were balanced on gender.

Results and Discussion

The anxiety manipulation was successful; the mean state anxiety scores of STAI significantly differed between groups: the mean state anxiety for the anxious group was 40.59 (SD=10.701) and for the control group was 36.05 (SD=9.977). That difference in state anxiety turned to be significant tested with ANOVA: $F(1, 89) = 4.327$, $p=0.040$. The mean trait anxiety scores, however, did not differed significantly between groups: $F(1, 89) = 0.293$, $p=0.590$ (means of 41.57 (SD=10.100) for the control condition and of 42.70 (SD=9.661) for the anxious condition). Hence, any difference between the groups should be due to that change in state anxiety, instead of some individual differences in trait anxiety. The difference in the state anxiety scores, however, is only 4.54, while the same difference in the Tohill and Holyoak Experiment 2 was 9.2[7]. Therefore, any direct comparisons between the two experiments seem not well-grounded.

The mean percentage of relational responses for all conditions is presented in Table 1.

A Repeated Measures ANOVA with one within-subject variable (complexity of the task: task with 2 options and task with 4 options) and one between-subject variable (the level of state anxiety: anxiety and control) was carried out on the accuracy data. The main effect of state anxiety on accuracy was not significant ($F(1, 88) = 0.001$, $p=0.970$, $\eta_{p^2} =0.000$) but the main effect of complexity on accuracy was significant ($F(1, 88) = 8.996$, $p=0.004$, $\eta_{p^2} =0.093$) such that

[7] State anxiety in the control condition of our experiment is 2.65 higher than in the Tohill and Holyoak's study, and 2.01 lower in the anxiety condition.

accuracy was higher when two alternatives were considered (86%), compared to four (78%).

Table 1: Mean percentage of relational mapping per condition.

Condition	%relational mappings
Control_2 alternatives	89%
Control_4 alternatives	75%
Anxiety_2 alternatives	83%
Anxiety_4 alternatives	81%

There was a significant interaction between complexity and anxiety, F (1, 88) = 5.724, p=0.019, η_{p^2} =0.019. The impact of complexity on accuracy was only significant for the control condition (Figure 4).

Interestingly, the 2x2 Repeated Measures ANOVA on response time revealed a main effect of complexity (F (1,88)=6.606, p=0.012, η_{p^2} =0.070: response times were less for 2 alternatives than for 4 alternatives condition, means of 4255.093msec and 4692.856msec, respectively) but not of anxiety (F (1,88) = 0.027, p=0.871, η_{p^2} =0.000). Besides, the interaction between complexity and anxiety was not significant: F (1,88)=0.274, p=0.602, η_{p^2} =0.003. Thus, the accuracy data are not explainable in terms of performance time, they are rather due to real differences in processing.

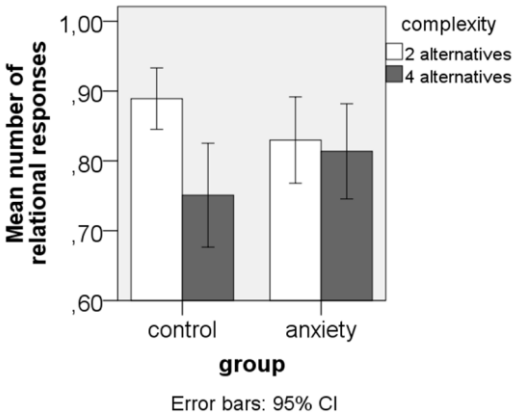


Figure 4: Mean number of relational mappings per condition.

To sum up, the obtained difference in accuracy but not in response time data only for the control group speaks in favor of processing that compensate the complexity of the task in high state anxiety. An increase in the number of alternatives slows the answers down significantly for both the control and anxiety groups. The accuracy, however, differs. If 4 alternatives require a higher level of inhibition to come up with a relational mapping as the results in the control condition seem to suggest, then the logical result would be that anxiety would diminish the accuracy for more complex tasks. Moreover, as Holyoak (2012) has pointed out, if anxiety reduces the available cognitive resources, crucial for the inhibition of irrelevant information, then it would hamper analogical mapping even more than in the control condition. That seems not to be the case in our data: participants in the anxiety condition do not differ in terms of accuracy when searching for a relational match among 2 or 4 alternatives.

However, the fact that state anxiety fosters encoding of objects as well as relations (Hristova & Kokinov, 2011) may suggest a plausible explanation of the obtained results. When the relational match is chosen between 2 and 4 alternatives, it is not only that the mapping becomes harder with the number of the available alternatives, the number of required relations that should be considered also increases. Hence, the state anxiety group would have an appreciable encoding superiority over the control group in the case of four alternatives: they will encode the necessary relations faster and may use the time for resolving the harder mapping. In other words, the superior encoding of the anxiety group may compensate for the difficulties in the subsequent mapping, associated with the more complex task. Of course, it is possible, actually quite probable, that the improvement of relational encoding and the suggested impoverished inhibition due to the state anxiety, depend on the level of anxiety. On one hand that may explain the inconsistency between the reported results and Tohill and Holyoak's data (2000, Experiment 2): the difference between the anxiety levels in the control and anxiety groups in their experiment was almost twice the difference in the current study. That might indicate quite different outcomes with regard to the Yerkes–Dodson Law (1908).

The experiment described here, however, points to an interesting interplay between the subprocesses of analogy making under anxiety.

Conclusion

The data from this experiment suggest that anxiety influences differentially the encoding of relations and the inhibition of alternative hypotheses, which are crucial for the final analogical mapping. Complexity does change relational mapping under low but not under high state anxiety.

In a recent paper Vendetti, Knowlton, and Holyoak (2012) varied the semantic distance between analogical domains and showed that anxiety does not decrease the number of correct relational responses, but increases the number of false alarms in verbal A:B::C:D analogies. This was interpreted as switching to a non-analogy strategy which looks for the superficial overlap of the domains, rather than their structure. That explanation, however, does not seem applicable to our data, since the superficial overlap between the two structures represented in the two pictures of each stimulus pair are identical, but differ only in the number of relations that should be considered in the case of 2 and 4 alternatives.

Finally, the current conflict between the data in the field can be explained both via differences in the complexity of the tasks and in the obtained level of state anxiety, which in turn highlights the importance of experiments that

manipulate anxiety on at least three levels (in order to capture a particular nonlinear relationship between anxiety and performance on analogy tasks), while controlling for the complexity of the given task.

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References

Becker, M. (2009). Panic Search: Fear produces efficient visual search for nonthreatening objects. *Psychological Science*, 20(4), 435-437.

Broadhurst, P.L. (1957). Emotionality and the Yerkes–Dodson law. *Journal of Experimental Psychology*, 54, 345–352.

Cho, S., Holyoak, K. J., & Cannon, T. D. (2007). Analogical reasoning in working memory: Resources shared among relational integration, interference resolution, and maintenance. *Memory and Cognition, 35*(6), 1445-1455.

Eysenck, M., & Calvo M. (1992). Anxiety and performance: The processing efficiency theory. *Cognition and Emotion*, 6, 409-434.

Eysenck, M. W., Deraksan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion*, 7, 336-353.

Feldman, V., Hristova, P., & Kokinov, B. (2010). How does anxiety influence analogical mapping? *Proceedings of the 32nd Annual Conference of the Cognitive Science Society*. Hillsdale, NJ: Erlbaum.

Holyoak, K. J. (2012). Analogy and relational reasoning. In K. J. Holyoak & R. G. Morrison (Eds.), *The Oxford handbook of thinking and reasoning*. New York: Oxford University Press.

Hristova, P., & Kokinov, B. (2011). Anxiety fosters relational encoding. In: B. Kokinov, A. Karmiloff-Smith, & N. Nersessian (Eds.), *European Perspectives on Cognitive Science*. Sofia: NBU Press.

Krawczyk, D. C., Morrison, R. G., Viskontas, I., Holyoak, J., Chow, T. W., Mendez, M. F., Miller, B. L., & Knowlton, B. J. (2008). Distraction during relational reasoning: The role of prefrontal cortex in interference control. *Neuropsychologia*, 46, 2020-2032.

Leon, M., & Revelle, W. (1985). Effects of anxiety on analogical reasoning: A test of three theoretical models. *Journal of Personality and Social Psychology*. 49(5), 1302-1315.

Markman, A. B., & Gentner, D. (1993). Splitting the differences: A structural alignment view of similarity. *Journal of Memory and Language*, 32, 517-535.

Pacheco-Unguetti, A., Acosta, A., Callejas, A., & Lupianez, J. (2010). Attention and anxiety: Different attentional functioning under state and trait anxiety. *Psychological Science*, 21(2): 298-304.

Phelps, E.A., Ling, S., & Carrasco, M. (2006). Emotion facilitates perception and potentates the perceptual benefits of attention. *Psychological Science*, 17, 292–299.

Posner, M.I., & Petersen, S.E. (1990). The attention system of the human brain. *Annual Review of Neuroscience, 13*, 25–42.

Posner, M.I., Rueda, M.R., & Kanske, P. (2007). Probing the mechanisms of attention. In J.T. Cacioppo, J.G. Tassinary, & G.G. Berntson (Eds.), *Handbook of psychophysiology*. Cambridge, England: Cambridge University Press.

Richert, R., Whitehouse, H., & Stewart, E. (2005). Memory and analogical thinking in high arousal rituals. In: H. Whitehouse & R.H. McCauley (Eds.), *Mind and religion: psychological and cognitive foundations of religiosity*. Walnut Creek, CA: AltaMira Press.

Spielberger, C.D., Gorsuch, R.L., & Lushene, R. (1970). *STAI manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Sweis, B.M., Bharani, K.L. & Morrison, R.G. (2012). The time course of inhibition in analogical reasoning: An event-related potential approach. In N. Miyake, D. Peebles, & R. P. Cooper (Eds.), *Proceedings of the 34th Annual Conference of the Cognitive Science Society*. Austin, TX: Cognitive Science Society, 1030-1035.

Tohill, J., & Holyoak, K. (2000). The impact of anxiety on analogical reasoning, *Thinking & Reasoning*, 6:1, 27 – 40.

Vendetti, M., Knowlton, B., & Holyoak, K. (2012). The impact of semantic distance and induced stress on analogical reasoning: A neurocomputational account. *Cognitive, Affective & Behavioral Neuroscience*, 12, 804-812.

Viskontas, I. V., Morrison, R. G., Holyoak, K. J., Hummel. J. E., & Knowlton, B. J. (2004). Relational integration, inhibition, and analogical reasoning in older adults. *Psychology and Aging*, *19*(4), 581-591.

Yerkes, R. M., & Dodson, J. D. (1908) The relation of strength of stimulus to rapidity of habit-formation. *Journal of Comparative Neurology and Psychology*, 18, 459-482.

Щетински, Д., Паспаланов, И. (1989). *Методическо пособие за работа с българската форма на въпросника за оценка на тревожността на Ч.Спилбъргър*. БАН – Институт по психология. (Bulgarian standardized version of Spielberger's STAI).