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Aha-cueing in problem solving

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Aha-cueing is defined as problem solving enhancement when subjects are administered expressions of insight. Two experiments were conducted to examine whether auditory Aha-cues can enhance anagram solving. While solving anagrams, the experimental group was exposed to expressions of insight. The control group performed the same task without being exposed to Aha-cues. In both experiments, the presentation of Aha-cues enhanced anagram solving. We present our findings within the context of feeling-as-information theory (Schwarz, 2011). We propose that feeling of insight holds adaptive functions and fosters specific problem solving strategies.

1. Introduction

Feeling-as-information theory is one of the most comprehensive frameworks for feeling and thinking issues (Schwarz, 2011). However such a remarkable and widely studied phenomenon as feeling of insight (Köhler, 1947) has remained so far beyond the scope of this theory. The present paper provides experimental data and presents a theoretical framework to incorporate the insight phenomenon into the feeling-as-information theory.

Feeling-as-information theory assumes that people attend to their affective (i.e. emotion, mood), cognitive (e.g., accessibility), and bodily (e.g. hunger, pain and physiological arousal) experiences as a source of information. Particularly, feelings can inform a person of the state of her or his problem-solving. Positive affect signals benignity, whereas negative affect is associated with problematic situations. Such information may provide "cognitive tuning" in order to adapt people's processing strategies to situational requirements (see Schwarz, 2004). Thus, systematic, bottom-up processing with considerable attention to details is generally most effective in problematic situations. So, negative affect, which signals of problematic situations, fosters this kind of processing. In contrast, positive affect yields more heuristic processing and increased reliance on the top-down use of pre-existing knowledge structures.

We propose that feeling of insight also informs of a specific state of problem solving. Cognitive system may use this information adaptively. Feeling of insight (Aha-experience) is associated with the moment when a person finds the solution to a problem (Köhler, 1947; Tikhomirov, 1984). Or, rather, it is associated with the moment when a person thinks he or she has found the solution. After experiencing an insight a person should usually proceed to further sequential verification of the candidate solution.

Anagrams give an example of this process as people often solve them in an insightful way (Bowden, 1997; Ellis, Glaholt, & Reingold, 2011; Medyntsev, 2011). Insight occurs when one realizes a word is a potential solution (e.g. for anagram "yooscghypl" one finds the word "psychology"). The solver should then run a sequential verification. He or she should verify the anagram contains the appropriate set of letters.

Thus, feeling of insight is associated with the preliminary identification of the solution, which takes place before the solution is sequentially verified. Such automatic instantaneous evaluation is similar to the recognition of a familiar face, which does not require the sequential analysis of its features (Liccione et al., 2014). The processes that invoke the feeling of insight emergence are not well studied. Recently, S. Topolinski and R. Reber introduced an interesting hypothesis that rests upon the concept of processing fluency. The increase of processing fluency causes a specific feeling that can be used for a decision making (Reber, Schwarz, & Winkielman, 2004; Topolinski & Reber, 2010). For example, enhancing fluency skews people's judgments towards presuming solvability of the task in hands (Topolinski & Strack, 2009).

Topolinski and Reber (2010) suggest that the feeling of insight is a reflection of the sudden increase of the processing fluency caused by the solution finding. When the solution comes into one's mind it increases the information processing fluency, and this in turn creates feeling of the easiness, joy and the rise of confidence. They demonstrate that increasing the processing fluency by the experimental manipulations can induce a feeling of insight without a solution being found.

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Topolinski and Reber's hypothesis requires more empirical evidence, but it fits the phenomenology of insight very well. Surprisingly, in most cases the insight evaluation of the candidate solution is correct. The question is how does this evaluation occur? Topolinski and Reber's hypothesis implies that the evaluation of a solution as a correct one does not stem from the analysis of its content, but rather from the cognitive processing pattern. This provides an explanation for an insight phenomenology paradox: the confidence in the solution emerges prior to its verification.

The evaluation of a solution through the change in the cognition pattern is heuristic: its accuracy is very high but not 100%. Sometimes the solution that comes into mind with feeling of insight may turn out to be illusive. There are two possible types of errors.

Type I error is false recognition error. For instance, when solving an anagram "leblta", one may feel an insight, having discovered the word "table". Although more accurate examination reveals that the letter "l" is odd. At the same time, such an insight is very unlikely for a word that has little in common with an anagram, e.g. "angle". The false insight phenomenon was described in the early introspective work of (Poincaré, 1913). Poincaré reported that sometimes the feeling of insight accompanied an idea which afterwards turned out to be false. He pointed out however that the idea followed with a false insight was always esthetically attractive.

Type II error happens when the solution appropriate information is activated but is not identified as relevant. In this case the necessary information is activated but insight does not occur and the problem is not solved. Shames (1994) findings support the idea that the correct answer may come in an implicit form and remain "closed in" for some time before it becomes accessible in consciousness. He found that after failing to solve items from the Remote Associates Test (RAT), subjects showed a significant priming effects when the solutions were presented in a lexical-decision task. Analogous results were reported by Sio and Ormerod (2009) and Zhong, Dijksterhuis, and Galinsky (2008).

Similarly Bowers, Regehr, Balthazard, and Parker (1990) showed that although subjects were not aware of the solution of RAT-like items, they were able to distinguish between solvable and unsolvable items at rates significantly greater than chance. The same was true for the ability to discriminate between incomplete figures of real objects and random combinations of lines (Bowers et al., 1990). Ellis et al. (2011) using eye-tracking showed that the subject often acquires solution knowledge prior to insight.

Thereby, activation of solution-relevant knowledge in long-term memory does not automatically imply its awareness and verification (Bowers et al., 1990; Shames, 1994; Zhong et al., 2008; Sio & Ormerod, 2009; Ellis et al., 2011). Some processing is needed to make it conscious. Thus, feeling of insight indicates that currently activated information matches solution criteria. The adaptive strategy in this case is to elaborate the solution and verify it. In the framework of feeling-as-information theory the adaptive function of feeling of insight would consist in inducing such a strategy. Empirical data suggest the functionality of insight-induced processing strategies. For example, Tikhomirov (1984) used bio-feedback to control the presence of insight feeling in problem solving. He showed that volitional suppression of skin conductance response decreases performance in insight tasks.

According to the feeling-as-information theory, people usually attribute their feelings to whatever is the main focus of their attention, and this can lead to misattribution of feelings. The theory distinguishes integral feelings, elicited by the target, from incidental feelings which happens to be present at a given time (Schwarz, 2011). Incidental feelings may influence processing strategies when erroneously attributed to the current task. Thus, experimentally induced positive or negative mood influences problem-solving strategies (Martin, Ward, Achee, & Wyer, 1993).

Based on the understanding of insight provided above and considering potential misattribution of feelings, we predict that the probability of insight solutions increases after a subject perceives insight expressed by others. We call this phenomenon "Aha-cueing".

Numerous anecdotes give evidence for Aha-cueing in real life situations. For example the chess grandmaster Nikolai Krogius reports this kind of experience when he was a Boris Spassky's assistant in the 1969 World Championship. Krogius and another Spassky's assistant Igor Bondarevsky were analyzing an adjourned game. The game seemed to be a draw, when suddenly Krogius got a striking idea disapproving all previous analyses. He writes: "I had just started the phrase 'What if…' and understood that Bondarevsky had made it out too" (Krogius, 1997, p. 29).

The proposed theoretical framework provides following reconstruction of the Aha-cueing phenomenon. A subject works on the problem and approaches the solution. Elements relevant to solution become activated in long-term memory but for some reasons remain subconscious. At this moment an insight expression of other person (Aha!-exclamations, gestures, mimics, etc.) provokes an incidental feeling of insight. Subject attributes this feeling of insight to target task and induces the search for existing implicit solution. The search reveals activated elements and integrates them into conscious solution.

Whereas the Aha-cueing phenomenon can be observed in real life, there is no scientific evidence for it. Experimental fact that Aha-cues enhance performance would support the theoretical framework described above. We conducted two studies to explore whether the Aha-cueing phenomenon can be induced in experimental settings.

2. Study 1

The experimental group was exposed to auditory expressions of insight while solving a set of anagrams. The control group performed the same task without being exposed to Aha-cue. We hypothesized that exposure to the Aha-cue would increase the number of anagrams solved.

3. Method

3.1. Participants

One hundred and eighty one secondary school students (65% girls, mean age 14.9 years (SD = 0.84)) participated in the experiment as a part of the emotional and cognitive ability test program. Participants were randomly assigned to either an experimental or control group.

3.1.1. Stimuli

Eighteen anagrams of 5–7 letters in length were used for the main session. For example, the solution of the anagram "елатб" is "балет" (the Russian word for ballet). Anagrams were presented in 32-size lowercase black font on a white background in the center of the computer screen.

Eighteen thirty-second audio tracks were digitally recorded with a sampling rate of 44,100 Hz. Tracks contained 18 different emotionally neutral narrations (extract from fiction) read out by a female voice. Audio tracks were presented through headphones parallel with the presentation of anagrams.

Every anagram was accompanied with an audio track (fixed for each anagram) starting simultaneously with the anagram presentation. For the experimental group, the story plot naturally implied the emotional exclamation in the sort of "aha!"-reaction (Aha-cues) which occurred at the 16th second of the track (between 15,000 and 16,000 ms). Each Aha-cue represents its own form of insight expression ("*Ah! It's clear!", "Oh! Got it!"* etc.). The control group listened to identical stories except that the Aha-cues were replaced with tonally neutral phrases.

3.1.2. Procedure

Participants were instructed that they would take a test designed to assess ability in focusing attention on a task (anagram solving) in the presence of distractors. They were notified that during the course of the problem-solving, they would hear a voice through the headphones, but to remain focused on solving the given task and ignore the audio track.

Stimuli were presented using the E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). Each experimental probe began with a fixation point (1500 ms). Then the anagram appeared at the screen and participants had to press "Answer" (with the space button) when they had found the encrypted word. Every anagram was presented on the screen until "Answer" was pressed but not for more than 30 s. After 30 s, the anagram disappeared and an answer-entry window popped-up. Participants could type a solution or leave the entry-field empty — and then press "Enter" to proceed to the next trial. For each trial we recorded accuracy, response time (from anagram presentation to "Answer" pressing) and typing time (time of operating with an answer-entry window).

The experiment began with a training session (three anagrams, with feedback of answer correctness) followed by main session (eighteen anagrams in a random order, without any feedback).

4. Results and discussion

Subjects who solved all anagrams after 30 s without pressing "Answer" were excluded from the analyses, as they did not follow the instructions. Also subjects whose average typing time exceeded 20 s were deleted from the analyses as they were suspected of solving anagrams after the time had been elapsed. Therefore, the dataset for the analysis included 148 subjects (72 in the experimental group and 76 in the control group). Only the data from the main session were analyzed. We arranged every response time to a definite second (from 1st to 30th) of the solving process (e.g. RT of 7335 ms turned into 8th second of problem-solving).

We found no significant differences between experimental and control groups neither in the total number of anagrams solved, nor in the number of anagrams solved before or after presentation of the Aha-stimulus (see Table 1 for descriptive statistics). A detailed analysis, however, revealed that there was a significant difference between the two groups in the number of correct solutions in the 21st second of problem solving ($t(146) = 2.21$, $p = .029$, Cohen's $d = 0.36$). This means that 4 s after the Aha-stimulus was presented the experimental group significantly outperformed the control group.

In all other points of problem-solving (from the 1st to the 30th second, except the 21st) the differences between groups were not significant. Enhancement in anagram solving in the experimental group was a short-term effect. The difference between groups in response rates for correct answers after the cue was not significant ($t(124) = 0.68$, $p = .496$).

We conducted a second study to replicate this phenomenon. In Study 1, the median time for solving an anagram was nearly 13 s, i.e. the majority of anagrams were solved before the cue presentation. In Study 2, we decided to shorten the time for a single probe and to shift the moment of the cue presentation to the earlier moment.

5. Study 2

5.1. Method

5.1.1. Participants

One hundred and thirty-six secondary school students (49% girls, mean age 14.85 years (SD = 0.96)) participated in the experiment as a part of the emotional and cognitive ability test program. This sample was completely independent from the Study 1. Participants were randomly assigned to either an experimental or control group.

5.1.2. Stimuli and procedure

The anagrams, audio tracks and procedure were the same as in Study 1, except that each anagram was presented for no more than 20 s and the aha-cue in the experimental group appeared on the 11th second, instead of the 16th.

6. Results and discussion

Subjects who solved all anagrams after 20 s without pressing "Answer" were excluded from the analyses as they did not follow the instructions. Also subjects whose average typing time exceeded 20 s were deleted from the analyses as they were suspected of solving anagrams after the time had elapsed. In total, the dataset included 101 subjects (51 in the experimental group and 50 in the control group).

Table 2 presents descriptive statistics for Study 2. As in Study 1, we found no significant differences between the experimental and control groups neither in the total number of anagrams solved, nor in the number of anagrams solved before or after the presentation of the Aha-stimulus. However as we expected, we found a significant difference between two groups in the number of correct solutions in the 14th second of problem solving ($t(99) = 2.34$, $p = .021$, Cohen's $d = 0.47$). In all other points of problem-solving the differences between groups were not significant.

Two studies show very similar results – the presentation of auditory aha-cue enhances anagram solving several seconds after its presentation. In Study 1, the interval between aha-cue and its effect was 5 s; whereas, in Study 2 it equaled only 3 s. It is possible that the difficulty level of anagrams could cause this difference as the anagrams to be solved in 11th second are easier than anagrams remained by 16th second.

7. Combined analysis of Studies 1 & 2

Our theoretical framework doesn't provide instruments to predict the exact moment of performance enhancement after the Aha-stimulus. Both theoretical considerations and real-life experience suggest that the effect should follow "quickly" after the stimulus. However, they don't allow exact estimation of time characteristics. This means that in our studies it was not possible to predict a priori the moment when the effect appears. Moreover the timing of performance enhancement may depend on task difficulty, readiness of the solution, and other peculiarities of the experimental situation. In two experimental studies with slightly different design the significant effect occurred in different

Table 1
Descriptive statistics and t-test for Study 1.

	Control		Experimental		
	M	SD	M	SD	t
Total number of anagrams solved	7.57	3.31	7.43	3.08	−0.26
Number of anagrams solved before cue	4.92	2.85	4.51	2.72	−0.89
Number of anagrams solved after cue	1.80	1.36	2.06	1.28	1.17
Number of anagrams solved in 21th second	0.09	0.29	0.22	0.42	2.21*

* $p < 0.05$.

Table 2
Descriptive statistics and t-test for Study 2.

	Control		Experimental		
	M	SD	M	SD	t
Total number of anagrams solved	6.02	2.50	6.31	2.41	0.60
Number of anagrams solved before cue	3.20	2.09	3.16	1.83	−0.11
Number of anagrams solved after cue	1.66	1.29	2.10	1.53	1.56
Number of anagrams solved in 14th second	0.06	0.24	0.24	0.47	2.34*

* $p < 0.05$.

time moments. This may bring up the question whether it is methodologically valid to compare only the moments of peak performance for each experimental condition without corrections for multiple comparisons. But corrections for multiple comparisons are impossible because we are unable to estimate a relevant amount of time points for the meaningful comparison.

To address this issue we combined data of the two studies and tested whether there is significant difference between experimental and control groups on the overall 5-s time interval after the Aha-stimulus. For each study we calculated the standardized mean performance on 5 s after the cue (i.e. 17th, 18th, 19th, 20th, and 21th seconds for Study 1, and 12th, 13th, 14th, 15th, and 16th seconds for Study 2) and introduced the new dependent variable – mean rate of anagram solving within 5 s after the cue. This variable was defined on the pooled sample of 249 subjects (148 from Study 1 and 101 from Study 2). We found a significant difference between experimental and control groups on this new variable: $t(247) = 2.19$, $p = .029$. So the combination of two studies shows significant performance enhancement in the 5-s time interval after Aha-stimulus.

8. Aha-cue effect and individual differences

It is interesting to explore whether there are some individual difference that make a person more prone to Aha-cues. For this purpose we examined gender differences, some cognitive abilities and task-specific measures.

Neither combined nor separate analysis of the two studies did not reveal any systematic gender differences in the Aha-cue efficacy. As our participants came from the larger emotional and cognitive ability test program we had additional data on their intelligence (measured by Raven's APM and verbal scale of Amthauer's IST), creativity (measured by Guilford's Unusual Uses test and Urban's Test for Creative Thinking — Drawing Production) and emotional intelligence (measured by a VideoTest (Lyusin & Ovsyannikova, 2014)). We didn't find any correlations between individual differences on these variables and Aha-cue effect.

We also examined individual differences on some task-specific measures such as number of anagrams solved before the Aha-cue presentation, general speed of anagram solving and speed of anagram solving before cue presentation. Concerning Study 1 analysis reveals that those subjects who showed the effect were significantly slower in general compared to those who didn't show the effect (mean anagram solving time 16,363 ms and 13,340 ms respectively, $(70) = 2.46$, $p = 0.017$), but not before the Aha-cue presentation. As this wasn't replicated in Study 2 (as well as in the combined study) such difference can be regarded as a consequence of rather late cue presentation in Study 1. For other variables we didn't find any significant differences between the subjects who showed the effect and those who didn't.

9. Discussion

Results from two experiments suggest that Aha-cues influence problem-solving performance. The presentation of auditory Aha-stimuli increased the number of anagrams solved. We propose the feeling-as-information perspective is a corroborating theoretical framework to account for this phenomenon. However several alternative explanations are possible.

The first explanation is “additional activation hypothesis”, which assigns more importance to the impact of semantic cues and semantic priming on problem-solving (Seifert, Meyer, Davidson, Patalano, & Yaniv, 1995; Yaniv & Meyer, 1987). Aha-cues could provide additional activation to semantic network elements. This hypothesis stems from Bower's (1981) network model and Lubart's and Getz's emotional resonance model (Getz & Lubart, 1998; Lubart & Getz, 1997; Zenasni & Lubart, 2011). Both models imply that connections exist between semantic and emotional elements and activation can spread through emotional nodes to semantic ones. When a subject is solving an anagram the activation of solution node could become rather high (Shames, 1994) but not enough to realize an answer. In this case the nonspecific influence from Aha-cues would raise activation of the solution node to the threshold of consciousness.

The second explanation draws on Zeelenberg and Bocanegra (2010) discovery that auditory presented emotional stimulus enhances subsequent neutral word recognition. We can extend their hypothesis assuming that emotional stimuli induce not only perceptual enhancement, but also cognitive enhancement in general. Thus “cognitive enhancement hypothesis” suggests that the emotional charge of Aha-stimulus mobilizes cognitive resources to problem-solving.

The third possibility — “insight priming hypothesis” — assumes that the Aha!-exclamation in our experiments could serve as “cultural artifact” (Slepian, Weisbuch, Rutchick, Newman, & Ambady, 2010) which is associated with insight and thus evokes the mental processes that facilitate problem-solving. Slepian et al. showed that exposure to an illuminating lightbulb increased performance on insight problems. The insight priming hypothesis is compatible with the theoretical framework suggested in the current paper. Slepian et al.'s approach allows for different interpretations of mental processes that takes place during the presentation of artifacts. According to our approach the cognitive system may take the cultural artifact as an indicator of a solution finding. The presentation of such artifacts triggers the mental process that could be considered as the search of already activated, but not yet perceived solution.

One of the limitations of our study was the inability to directly test alternative hypotheses. However, it is possible to test empirically the validity of alternative explanations of Aha-cueing. For example, according to the feeling-as-information theory, if the subject knows in advance about the presence of Aha-cues in experiment this knowledge will reduce misattribution of feeling of insight. Consequently, the feeling-as-information theory predicts that Aha-cueing effects would diminish or vanish in these conditions.

10. Conclusion

The incorporation of insight makes the feeling-as-information theory more comprehensive. At the same time, studies of insight could also benefit from further investigations of Aha-cueing. Current theories of insight focus on information processing that lead to the representation restructuring. Some researchers consider insight as a consequence of conscious, controlled, and attention-demanding processes (e.g., Kaplan & Simon, 1990). Others suggest the automatic redistribution of activation in semantic network as a source of insight (Ash & Wiley, 2006; Seifert et al., 1995).

The theoretical framework proposed in this paper aligns with the latter approach. However this approach needs two additions in order to explain the Aha-cueing phenomenon. First, the feeling of insight manifests itself as a signal for high-level processes that the solution is probably found at lower level. This feeling, therefore, may evoke a useful adaptive process. Second, the feeling of the solution correctness is not determined by a detailed analysis of the solution, but by a sudden change in the low-level information processing pattern. The Aha-cueing phenomenon expands the scope of insight studies beyond the information-processing mechanisms: it suggests that insight studies should also include the specific feelings that accompany insight solutions.

Another perspective links Aha-cueing to social psychology, particularly to a group problem solving. In Aha-cueing one's feelings about the problem trigger specific information processing strategies in another person. These processes of mutual cognitive tuning represent a potential interest for research in leadership and stimulation or inhibition of creativity.

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References

Ash, I. K., & Wiley, J. (2006). The nature of restructuring in insight: An individual-differences approach. *Psychonomic Bulletin & Review*, *13*(1), 66–73. http://dx.doi.org/10.3758/BF03193814.

Bowden, E. M. (1997). The effect of reportable and unreportable hints on anagram solution and the aha! experience. *Consciousness and Cognition*, *6*(4), 545–573. http://dx.doi.org/10.1006/ccog.1997.0325.

Bower, G. H. (1981). Mood and memory. *American Psychologist*, *36*, 129–148. http://dx.doi.org/10.1037/0003-066X.36.2.129.

Bowers, K., Regehr, G., Balthazard, C., & Parker, K. (1990). Intuition in the context of discovery. *Cognitive Psychology*, *22*(1), 72–110. http://dx.doi.org/10.1016/0010-0285(90)90004-N.

Ellis, J. J., Glaholt, M. G., & Reingold, E. M. (2011). Eye movements reveal solution knowledge prior to insight. *Consciousness and Cognition*, *20*(3), 768–776. http://dx.doi.org/10.1016/j.concog.2010.12.007.

Getz, I., & Lubart, T. I. (1998). The emotional resonance model of creativity: Theoretical and practical extensions. In S. W. Russ (Ed.), *Affect, creative experience, and psychological adjustment* (pp. 41–56). Philadelphia, PA: Brunner-Mazel.

Kaplan, C. A., & Simon, H. A. (1990). In search of insight. *Cognitive Psychology*, *22*(3), 374–419. http://dx.doi.org/10.1016/0010-0285(90)90008-R.

Köhler, W. (1947). *Gestalt psychology: An introduction to new concepts in modern psychology*. New York: Liveright Pub. Corp.

Krogius, N. (1997). Ty prav Boris? Sub"ektivnye zametki o yubilare. *Are you right, Boris? Subjective notes about hero of the day. 64 - Shakhmatnoe Obozrenie*, *1*. (pp. 28–31).

Liccione, D., Moruzzi, S., Rossi, F., Manganaro, A., Porta, M., Nugrahaningsih, N., ... Allegri, N. (2014). Familiarity is not notoriety: phenomenological accounts of face recognition. *Frontiers in Human Neuroscience*, *8*, 10. http://dx.doi.org/10.3389/fnhum.2014.00672.

Lubart, T. I., & Getz, I. (1997). Emotion, metaphor and the creative process. *Creativity Research Journal*, *10*, 285–301. http://dx.doi.org/10.1207/s15326934crj1004_1.

Lyusin, D., & Ovsyannikova, V. V. (2014). A new videotest for measuring emotion recognition ability. *Working papers by NRU Higher School of Economics. Series PSY "Psychology", WP BRP 16/PSY/2014* (Retrieved from: http://www.hse.ru/pubs/share/direct/document/112965245).

Martin, L. L., Ward, D. W., Achee, J. W., & Wyer, R. S. (1993). Mood as input: People have to interpret the motivational implications of their moods. *Journal of Personality and Social Psychology*, *64*(3), 317–326. http://dx.doi.org/10.1037//0022-3514.64.3.317.

Medyntsev, A. A. (2011). Vliyanie rezyl'tatov vypolneniya pobochnogo zadaniya na kolichestvo reshenij ozareniyami pri razgadyvanii anagramm [The influence of second task performance on the number of insights in anagram solving]. *Proceedengs of the annual conference of Institute of Psychology of Russian Academy of Sciences*. Moscow: Institute of psychology RAS.

Poincaré, H. (1913). *The Foundations of Science*. Lancaster, PA: Science Press.

Reber, R., Schwarz, N., & Winkielman, P. (2004). Processing fluency and aesthetic pleasure: is beauty in the perceiver's processing experience? *Personality and Social Psychology Review: An Official Journal of the Society for Personality and Social Psychology, Inc.*, *8*(4), 364–382. http://dx.doi.org/10.1207/s15327957pspr0804_3.

Schwarz, N. (2011). Feelings-as-information theory. In P. A. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), *Handbook of theories of social psychology: Collection: Volumes 1 & 2. vol. 1*. (pp. 289–308). SAGE Publications (Retrieved from http://www.google.ru/books?id=SePipgh2z7kC).

Seifert, C. M., Meyer, D. E., Davidson, N., Patalano, A. L., & Yaniv, I. (1995). Demystification of cognitive insight: Opportunistic assimilation and the prepared-mind hypothesis. In R. J. Sternberg, & J. E. Davidson (Eds.), *The nature of insight* (pp. 65–124). Cambridge, Massachusetts: The MIT Press (Retrieved from http://wesscholar.wesleyan.edu/cgi/viewcontent.cgi?article=1228&context=div3facpubs).

Shames, V. A. (1994). Is there such a thing as implicit problem solving? Unpublished doctoral dissertation. University of Arizona.

Sio, U. N., & Ormerod, T. C. (2009). Mechanisms underlying incubation in problem-solving: Evidence for unconscious cue assimilation. In N. A. Taatgen, & H. van Rijn (Eds.), *Proceedings of the 31st Annual Conference of the Cognitive Science Society* (pp. 401–406). Amsterdam: Cognitive Science Society.

Slepian, M. L., Weisbuch, M., Rutchick, A. M., Newman, L. S., & Ambady, N. (2010). Shedding light on insight: Priming bright ideas. *Journal of Experimental Social Psychology*, *46*, 696–700. http://dx.doi.org/10.1016/j.jesp.2010.03.009.

Tikhomirov, O. K. (1984). *Psikhologiya myshleniya [Psychology of thought]*. Moscow: MSU.

Topolinski, S., & Reber, R. (2010). Gaining insight into the "Aha" experience. *Current Directions in Psychological Science*, *19*, 402–405. http://dx.doi.org/10.1177/0963721410388803.

Topolinski, S., & Strack, F. (2009). Scanning the "Fringe" of consciousness: What is felt and what is not felt in intuitions about semantic coherence. *Consciousness and Cognition*, *18*, 608–618. http://dx.doi.org/10.1016/j.concog.2008.06.002.

Yaniv, I., & Meyer, D. E. (1987). Activation and metacognition of inaccessible stored information: potential bases for incubation effects in problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *13*(2), 187–205.

Zeelenberg, R., & Bocanegra, B. R. (2010). Auditory emotional cues enhance visual perception. *Cognition*, *115*, 202–206. http://dx.doi.org/10.1016/j.cognition.2009.12.004.

Zenasni, F., & Lubart, T. (2011). Pleasantness of creative tasks and creative performance. *Thinking Skills and Creativity*, *6*(1), 49–56. http://dx.doi.org/10.1016/j.tsc.2010.10.005.

Zhong, C. -B., Dijksterhuis, A., & Galinsky, A. D. (2008). The merits of unconscious thought in creativity. *Psychological Science*, *19*(9), 912–918. http://dx.doi.org/10.1111/j.1467-9280.2008.02176.x.