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Aha-cueing in problem solving

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ABSTRACT

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

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increasing the processing fluency by the experimental manipulations can induce a feeling of insight without a solution being found.

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 "елагб" 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.

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