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Gaining Insight Into the "Aha" Experience

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Abstract
The literature on insight lists four main characteristics of this experience: (a) suddenness (the experience is surprising and immediate), ease (the solution is processed without difficulty), positive affect (insights are gratifying), and the feeling of being right (after an insight, problem solvers judge the solution as being true and have confidence in this judgment). Although this phenomenology is well known, no theory has explained why insight feels the way it does. We propose a fluency account of insight: Positive affect and perceived truth and confidence in one's own judgment are triggered by the sudden appearance of the solution for a problem and the concomitant surprising fluency gain in processing. We relate earlier evidence on insight concerning the impact of sudden fluency variations on positive affect and perceived truth and confidence.

Keywords
affect, confidence, insight, judged truth, processing fluency, surprise

The sudden appearance of a solution through insight, the famous aha effect, is a peculiar phenomenal experience that people have when they solve a problem, as the following example illustrates. After working for weeks on new kinds of mathematical transformations, mathematician Henri Poincaré stopped working and went on a geological excursion, during which he put the mathematical problem out of his mind. One day on that trip, he entered a bus: "Just as I put my foot on the step, the idea came to me, though nothing in my former thoughts seemed to have prepared me for it, that the transformations I had used to define Fuchsian functions were identical with those of non-Euclidean geometry. . . . I made no verification . . . but I felt absolute certainty at once" (Poincaré, 1913/1996, p. 53). Only days later, after having returned home, he verified this discovery. When later studying arithmetic questions without apparent success, Poincaré again one day experienced an idea coming to him "with the same characteristics of conciseness, suddenness, and immediate certainty" (p. 54). Why is an insight accompanied by such experiences? According to Poincaré (p. 59), insight is "a real aesthetic feeling that all true mathematicians recognize, and this is truly sensibility," capable of eliciting "aesthetic emotion."

Poincaré's descriptions illustrate the main characteristics of the experience of insight:

- *Suddenness*. The solution of the problem pops into mind abruptly and surprisingly (Gick & Lockhart, 1995; Metcalfe & Wiebe, 1987).
- *Ease*. However difficult the problem-related processing might have been before, it is processed fast and easily after a solution has been found.

For some experts, these two features constitute the pivotal moment of insight and are sufficient to form the definitional core of it (Gick & Lockhart, 1995; Metcalfe & Wiebe, 1987). However, two further experiences closely accompany insight:

- *Positive affect*. An insight yields a genuine positive affective experience (Gruber, 1995); this positive affect comes before the assessment of the solution and therefore is not pride.
- *Truth and confidence*. After an insight, problem solvers judge the solution as being true and express confidence in that judgment, even before systematically assessing the solution's veracity in a formal analysis (Gick & Lockhart, 1995).

In sum, insight is an experience during or subsequent to problem-solving attempts, in which problem-related content comes to mind with sudden ease and provides a feeling of

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pleasure, the belief that the solution is true, and confidence in this belief.

Although a body of excellent research has examined the cognitive and brain processes that may lead up to an insight (see Kounios & Beeman, 2009; Metcalfe & Wiebe, 1987), there is no coherent explanation for the *phenomenology* (i.e., experience) of insight. This is astonishing, since for many researchers the phenomenology is sufficient to define insight (e.g., Kounios & Beeman, 2009; Gick & Lockhart, 1995; Metcalfe & Wiebe, 1987). Most crucially, problem solvers' self-reports regarding this experience are often the only indicators of whether a problem has been solved by insight or not. Indeed, recent brain-imaging studies on insight have been unable to provide other markers of the process (see Kounios & Beeman, 2009). To better understand the conceptual and methodological significance of the phenomenology of the insight experience, it is important to try to advance from a first-person perspective (based on data only accessible to the subject) to a third-person perspective (based on data observable from outside) by explaining why an insight feels the way it does.

Insight and Processing Fluency

Recent research in cognitive and social psychology has identified processing fluency as a feeling state that helps integrate the experiential components of insight. Processing fluency is the ease with which information is processed in the cognitive system (see Reber, Schwarz, & Winkielman, 2004)—pertaining, for instance, to perceptual input, semantic representations, or the retrieval of memory contents.

Our basic hypothesis is that the solution of a problem, popping up suddenly and exhibiting an increase in processing fluency, triggers both positive affect and confidence in the truth of the solution, as is implied by a body of evidence from fluency research. In the following, we will review evidence and relate it to insights concerning the impact of fluency on (a) positive affect, (b) judged truth and confidence, and (c) the importance of suddenness.

The Pleasure of Ease

Processing fluency depends on content-independent dynamics of information processing, namely the ease and speed with which the processing succeeds independent of content (Reber et al., 2004). With respect to insight, fluency reflects the *rush of insight* (Gick & Lockhart, 1995), the ease with which the solution is understood. Fluency can be manipulated by such procedures as exposing individuals to the same stimulus repeatedly, or by changing stimulus attributes like figure-ground contrast or symmetry.

High processing fluency per se appears to be hedonically marked, because stimuli that are processed easily and rapidly are preferred to stimuli that are difficult to process (Winkielman & Cacioppo, 2001; Topolinski & Strack, 2009a). Fluency triggers positive affect even outside of awareness, as indicated by automatic facial responses to subjectively undetected fluency gains (Topolinski, Likowski, Weyers, & Strack, 2009). This genuine consequence of fluency may resemble the joy that comes with the aha experience and may result in the aesthetic emotion that Poincaré (1913/1996) thought intimately accompanies insight.

Remember that Poincaré thought that the aesthetic emotion and his absolute certainty were somehow related. Indeed, processing fluency increases both positive affect and judged truth (Reber et al., 2004), as is discussed in the following section.

Effects of Fluency on Judged Truth and Confidence

Fluency triggers not only affective preferences but a broad range of other judgments, including ratings of loudness, clarity, or familiarity of a stimulus (see Reber et al., 2004). Importantly for the present account, high fluency also increases judgments of truth and confidence. In an experiment by Reber and Schwarz (1999), participants had to judge whether statements of the form ''Osorno is in Chile'' were true. Half of the statements were presented in a dark color against a white screen background, yielding high figure–ground contrast; other statements were shown with less contrast so that the statements were still readable but took more time to process, as assessed with a clarification task. The authors found a small but reliable effect of this contrast manipulation on judgments of truth: Statements printed in high rather than low contrast against a background were more likely to be judged as being true (see Unkelbach, 2007, Experiment 1; and Rhodes & Castel, 2008; for strong fluency effects on judgments).

Fluency influences not only the apparent truth ratings of statements but also confidence in one's own performance. When a general-knowledge question is easily processed, people are more confident in their capability of answering it correctly, independently of their actual capability (Koriat & Levy-Sadot, 2001). When, in turn, an answer to a general-knowledge question is easily retrieved, people are more confident in their general memory content, independently of their actual knowledge (Benjamin, Bjork, & Schwartz, 1998). Most significantly, the ease and speed with which an answer pops into people's minds increase their belief in the truth of this answer—again, independently of its actual correctness (Kelley & Lindsay, 1993). These findings show that fluent processing increases judged truth and a person's confidence in their capability, an experience that resembles the feeling of truth and confidence that accompanies a sudden insight.

The Role of Suddenness

Insights come suddenly. This characteristic has been observed empirically: Metcalfe and Wiebe (1987) asked participants to continuously assess their progress on solving insight problems by rating their ''feeling of warmth'' concerning the distance to a proper solution. It turned out that these feeling-of-warmth ratings remained stable at a low level until the eventual moment of insight, at which point they rose rapidly. This suggests that

people appear to feel low levels of fluency during much of the problem-solving process and cannot anticipate the moment of insight. Then, suddenly, the problem solver experiences insight with abruptly rising fluency of the emerging solution, as described by Poincaré (1913/1996). Recent research supports the idea that this discrepancy between processing fluency before and after the appearance of the solution may be one component of the aha experience.

In their pioneering work on discrepant fluency, Whittlesea and Williams (1998) let participants study a list of words. In a later test phase, the participants were presented with real words (e.g., "TABLE") and homophones of real words (e.g., "PHRAWG," sounding like "frog"). In a recognition test, new homophones not shown in the study list were more likely to be judged "old" than were new words. According to Whittlesea and Williams (1998), pronouncing real words like "table" was done easily, as was the retrieval of the meaning of real words, so that fluency was not surprising. However, initially participants were nonfluent when pronouncing a novel pseudoword like PHRAWG. Once having pronounced the pseudoword, however, its phonic resemblance to a well-known word whose meaning could be easily retrieved resulted in a surprising fluency gain. Participants attributed this surprising fluency to an earlier encounter with this word, resulting in more false alarms.

This finding was recently extended by Hansen, Dechêne, and Wänke (2008), who demonstrated that fluency increased subjective truth only when the level of fluency was surprisingly high. Specifically, they replicated the above-mentioned experiment by Reber and Schwarz (1999), with the exception that they presented blocks of six statements with the same contrast—for example first six statements with low figure–ground contrast (moderately fluent) and then six statements with high figure–ground contrast (fluent). They found that when a fluent statement appeared as the last statement within the block of fluent statements, judged truth was not higher than it was for less fluent statements in other blocks. In contrast, fluent statements were judged as more truthful when a fluent statement immediately followed a block of six less fluent statements. Thus, *surprising* fluency increased judged truth. The findings of this study suggest that change in fluency is a prerequisite for the judgmental consequences of fluency.

Finally, in a recent study that specifically targeted suddeness, Topolinski and Reber (2010) manipulated the immediacy of the appearance of a solution after a problem. One experiment varied the onset time (50 milliseconds vs. 150 milliseconds) of the appearance of solutions to anagrams. Participants were presented with anagrams that either resulted in a German word (e.g., "GEWIKITE"), or that did not (e.g., "GELIKITE"), followed by a blank screen. Then, the solution word (here: "EWIGKEIT," which means eternity) appeared, with a delay of either 50 or 150 milliseconds. Solutions presented with a delay of 50 milliseconds were more likely to be endorsed than solutions shown after 150 milliseconds, regardless of whether or not the solutions to the anagrams were actually correct. This experiment provides evidence that the sudden onset of a solution is sufficient to change its judged correctness. The findings reviewed in this section fit anecdotal observations that sudden flashes of insight increased the belief that a theory is true (Poincaré, 1913/1996).

Conclusion

Given the considerations above, we can now integrate the phenomenal components of the aha experience into a unifying account of this experience and can identify processing fluency as the glue between its experiential features. When a solution to a problem pops into a person's mind suddenly, information that has been difficult to process can be processed more fluently. This sudden change in processing fluency increases positive affect, the judged truth of the solution (independently of its actual truth), and subjective confidence in this truth judgment. Our hypothesis integrates experiential features of insight that were only loosely connected in the prior literature by identifying them as being not only essential concomitants of insight but even integral parts of the underlying causal mechanism—namely, sudden changes in fluency when processing the problem and its solution.

This account complements research in cognitive psychology and neuroscience by opening a path from a first-person perspective on the phenomenology of insight to a third-person perspective. Moreover, our account makes several novel predictions. On the one hand, future research might manipulate the determinants and direct concomitants of the insight experience, including fluency (Reber et al., 2004), suddenness (Topolinski & Reber, 2010), or affect (Topolinski & Strack, 2009b) to elucidate the causal architecture of this experience. Our crucial prediction is that aha experiences entailing mild pleasure and confidence can be induced experimentally, thus creating *illusions of insight*. In this regard, we predict that the currently featured procedural determinants are sufficient conditions to evoke an insight experience. Thus, even a trivial idea can become a momentary aha experience if sudden fluency in processing this idea is induced.

On the other hand, the phenomenology of insight can be examined more objectively than it has been to date. The affective consequences of insight experiences, such as immediate positive affect, can be measured by assessing the activity of the zygomaticus major—the "smiling muscle" (e.g., Topolinski et al., 2009; Winkielman & Cacioppo, 2001). The judgmental consequences of insight experiences, such as felt confidence, may be measured by letting participants bet money on a decision outcome (Persaud, McLeod, & Cowey, 2007). Such measures can be used as objective markers to determine the emergence of insight beyond subjective self-reports (cf., Kounios & Beeman, 2009). Finally, on conceptual grounds, our fluency hypothesis raises the challenge of how insight might be related to similar yet distinct cognitive feelings, such as the feeling of knowing, or intuition, that—interestingly—also have been shown to draw on processing fluency (Koriat & Levy-Sadot, 2001; Topolinski & Strack, 2009a; 2009b).

Recommended Reading

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