Title
Learning via Insight

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Problem solving can be understood as a very active learning strategy which is also being employed in education, even though the mechanisms behind it are poorly understood (Loyens, Kirschner, & Paas, 2012). Insight in problem solving is often heralded as a moment of blinding understanding which generates a great deal of motivation (Liljedahl, 2005). Research on insight focuses on these moments, examining the cognitive processes that lead to this feeling of sudden understanding alongside the solution, and on methods of eliciting these electrifying sensations reliably (e.g., **Webb**, Little, & Cropper, 2017). An important consideration in insight research is the considerable differences in operationalizations of "insight" between studies. For example, Mednick (1962) operationalised insight/creativity as the ability to solve a verbal association problem (the remote associates task, RAT), in which participants are presented with three remotely associated words, and are required to find a single fourth word that provides a common link between the three (e.g., cottage, blue, goat–cheese). If the words were already closely associated, it would not require creativity to find the missing link. Insight has therefore sometimes been operationalized as a sudden switch from a state of incomprehension, to a state of comprehension, which might be induced by presenting the solution (Auble et al., 1979; Webb et al., 2018). This definition has held for a long time, with substantial shifts in more recent years. Increasingly, the presence of a subjective ''aha!'' experience is considered necessary to interpret a solution to a problem as an insight (e.g., Bowden & Jung-Beeman, 2003). Finally, some researchers have proposed that insight does not necessarily include a state of incomprehension, but needs mental restructuring (Wills, Estow, Soraci, & Garcia, 2006).

Protocol analysis and neuroimaging techniques are used to explore brain areas that are active when an insight is achieved (e.g., **Becker**, Sommer, & Kühn, 2019; **Kizilirmak** et al., 2019). However, there is a wide variety of laboratory tasks (Threadgold, Marsh, & **Ball**, 2018; **Webb** et al., 2017), methodologies, and analyses. An important development in understanding insight is the use of computational models to more specifically predict the underlying cognitive processing. The CLARION model (Hélie & Sun, 2010) was an excellent step in this field; however other recent models investigate the use of reinforcement learning to investigate the processes underlying insight (**Colin** & Belpaeme, 2019).

The participants in this symposium, in alphabetical order, are Linden J. Ball, Maxi Becker, Thomas R. Colin, Jasmin M. Kizilirmak, and Margaret E. Webb (discussant).

Ball investigates component cognitive processes involved in the solution of an adaptation of Mednick's (1962) RAT, the compound remote associates task (CRAT; Bowden & Jung-Beeman, 2003). Despite many studies that have examined performance with RAT items, controversy remains regarding the component processes involved in their solution, with lexical-semantic and associative processes dominating current accounts. Ball reports on three studies that aimed to shed further light on the component processes underpinning CRAT performance by using the mere presence of task-irrelevant sound as a key theoretical tool. With three experiments, Ball demonstrates that both semantic activation and sub-vocalisation are important determinants of successful creative thinking with CRA items, with the suggestion being that semantic activation underpins solution-generation processes whereas sub-vocalisation underpins solution-evaluation processes.

Becker investigates insight problem solving by exploring the subjective aha experience as a function of the restructuring of a problem. While there is a long history of considering the aha experience as the direct consequence of restructuring (e.g. Danek, 2018; Kounios & Beeman, 2014), Becker shows that the aha experience does not always result from prior restructuring and that solutions with accompanied aha experiences do not underlie a single neuro-cognitive process. Becker shows that solutions with accompanied aha experience differ in their behavioral, neural and eye-tracking related signature as a function of restructuring. These have two major implications for insight research: First, from only measuring the subjective aha experience especially using CRATs it cannot be implied anymore that restructuring has occurred. Second, it is vital to experimentally separate the different components of insight to better understand its underlying diverse neuro-cognitive processes.

Kizilirmak will talk about age-related decline in episodic long-term memory formation and present first evidence that learning from insight may represent a beneficial learning strategy for the elderly. Kizilirmak presents a behavioral study on learning from insight using CRATs. She compared performance on insight problem solving and later memory performance for 30 young (18-35 yrs) and 31 older adults (60-85 yrs). First results suggest that older adults profited more from insight regarding the correct recognition of old CRA compared to control items, suggesting that insight facilitates episodic encoding.

Colin applies a computational learning model to the process of insight, outlining a hierarchical reinforcement learning theory of the insightful discovery of multi-step solutions. Colin focuses on insight as characterized by sudden restructuring and a simultaneous aha experience. While this is straightforward in a simple problem (as many commonly used insight problems are), subjective suddenness is surprising for problems requiring multiple actions to solve. For such problems, one might expect a delay following restructuring, corresponding to the time needed for mental look-ahead to validate the multi-step solution. Colin presents a mechanism for insight problem-solving based on hierarchical reinforcement learning, which explains restructuring as an option-switch, and the aha experience as a temporal difference error. Colin's approach highlights the value of combining computational models with the neuroscientific approach in aiding our understanding of how creative insights come to pass.

References

Auble, P. M., Franks, J. J., & Soraci, S. A. (1979). Effort toward comprehension: Elaboration or "aha"? *Memory & Cognition*, *7*(6), 426–434.

Becker, M., Sommer, T., & Kühn, S. (2019). Verbal insight revisited: fMRI evidence for early processing in bilateral insulae for solutions with AHA! experience shortly after trial onset. *Human Brain Mapping*, (August), 1–16.

Bowden, E. M., & Jung-Beeman, M. (2003). Normative data for 144 compound remote associate problems. *Behavior Research Methods, Instruments, & Computers*, *35*(4), 634–639. https://doi.org/10.3758/BF03195543

Colin, T. R., Belpaeme, T., Cangelosi, A., & Hemion, N. (2016). Hierarchical reinforcement learning as creative problem solving. *Robotics and Autonomous Systems*, *86*, 196–206. https://doi.org/10.1016/j.robot.2016.08.021

Danek, A. H. (2018). Magic tricks, sudden restructuring, and the Aha! experience: A new model of nonmonotonic problem solving. In F. Vallee-Tourangeau (Ed.), *Insight: On the Origins of New Ideas*. Psychology Press.

Hélie, S., & Sun, R. (2010). Incubation, insight, and creative problem solving: A unified theory and a connectionist model. *Psychological Review*, *117*(3), 994–1024. https://doi.org/10.1037/a0019532

Kizilirmak, J. M., Schott, B. H., Thürich, H., Richter, A., Sweeney-Reed, C. M., & Richardson-Klavehn, A. (2019). Learning of novel semantic relationships via sudden comprehension is associated with a hippocampus- independent network orchestrated by the mPFC. *Consciousness and Cognition*, *69*(January), 113–132.

Kounios, J., & Beeman, M. (2014). The Cognitive Neuroscience of Insight. *Annual Review of Psychology*, *16*(3), 190–191.

Liljedahl, P. G. (2005). Mathematical discovery and affect: the effect of AHA! experiences on undergraduate mathematics students. *International Journal of Mathematical Education in Science and Technology*, *36*(2–3), 219–234.

Loyens, S. M. M., Kirschner, P. A., & Paas, F. (2012). Problem-based learning. In K. R. Harris, S. Graham, T. Urdan, A. G. Bus, S. Major, & H. L. Swanson (Eds.), APA Educational Psychology Handbook: Vol. 3. Application to learning and teaching (Vol. 2). https://doi.org/10.1037/13275-000

Mednick, S. A. (1962). The associative basis of the creative process. *Psychological Review*, *69*(3), 220–232. https://doi.org/10.1037/h0048850

Threadgold, E., Marsh, J. E., & Ball, L. J. (2018). Normative Data for 84 English Rebus Puzzles. *Frontiers in Psychology*, *9*(December), 2513. https://doi.org/10.3389/FPSYG.2018.02513

Webb, M. E., Little, D. R., & Cropper, S. J. (2017). Once more with feeling: Normative data for the aha experience in insight and non-insight problems. *Behavior Research Methods*, *50*(5), 2035–2056.

Webb, M. E., Cropper, S. J., & Little, D. R. (2018). "Aha!" is stronger when preceded by a "huh?": Presentation of a solution affects ratings of aha experience conditional on accuracy. *Thinking & Reasoning*, *0*(0), 1–40. https://doi.org/10.1080/13546783.2018.1523807