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COMMENTARY

The Relationship Between Working Memory and Insight Depends on Moderators: Reply to Chuderski and Jastrzêbski (2017)

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Chuderski and Jastrzêbski (2017) found a positive relationship between working memory capacity and insight problem solving, and concluded that "people with less effective cognition" are therefore "less creative" (p. 2003). This interpretation discounts substantial evidence that devoting less executive control facilitates insight. We develop an initial framework for understanding these contradictory findings. We describe (a) how both working memory-demanding processes and less-demanding associative processes impact insight and (b) how individual, situational, and task-specific factors interact to influence whether greater working memory is a help or a hindrance. We propose that insight will be supported if the level of executive control used matches the level of control optimal for different phases of insight problem solving. We use this framework to explain why Chuderski and Jastrzębski's (2017) findings may have differed from DeCaro, Van Stockum, and Wieth (2016), and offer direction for a more unified account of insight problem solving.

Keywords: insight, problem solving, working memory, attention, executive control

Insight occurs when individuals reflect on problems in new and unexpected ways, overcoming conventional approaches. Because insight is a key mechanism of flexible problem solving, many researchers are interested in discovering its underlying cognitive processes. It is well established that both executive control processes that rely on working memory (WM) and attention, and associative processes that operate largely outside executive control, influence insight problem-solving (Bowden, Jung-Beeman, Fleck, & Kounios, 2005). However, the exact nature of this relationship is unclear (Dietrich & Kanso, 2010). And, in fact, WM-demanding and associative processes may sometimes be at odds (e.g., Bocanegra & Hommel, 2014; Chrysikou, Weber, & Thompson-Schill, 2014). Here, we provide a theoretical response to Chuderski and Jastrzębski (2017), who concluded that executive control processes benefit, rather than hinder, insight. We also call for more systematic investigation of insight problem solving as part of a complex, multiply determined cognitive system, rather than a compartmentalized process.

Like Chuderski and Jastrzębski (2017), many studies have demonstrated a positive relationship between executive control and insight (Chein & Weisberg, 2014; Chein, Weisberg, Streeter, & Kwok, 2010; De Dreu, Nijstad, Baas, Wolsink, & Roskes, 2012; Gilhooly & Fioratou, 2009; Ricks, Turley-Ames, & Wiley, 2007). These findings are consistent with the *business-as-usual* perspective, which posits that insight problem-solving relies on the same executive control processes as more deliberative, noninsight problems (Ball, Marsh, Litchfield, Cook, & Booth, 2015). These findings appear to contradict a growing literature that, like DeCaro et al. (2016), has found that having more available WM actually impedes insight (Ball et al., 2015; Beilock & DeCaro, 2007; Jarosz, Colflesh, & Wiley, 2012; Reverberi, Toraldo, D'Agostini, & Skrap, 2005; Van Stockum & DeCaro, 2014; Wieth & Zacks, 2011). These findings align with the *special-process* view, where insight is thought to rely at least in part on associative processes that operate largely outside of executive control, like spreading activation in semantic memory (see Bowden et al., 2005). To make sense of such contradictory findings, and inform a broader understanding of insight problem solving, future research must move beyond simply documenting effects and instead establish (a) how both WM-demanding and less-demanding associative processes impact insight and (b) what factors determine when higher WM helps versus hinders insight.

DeCaro et al. (2016) demonstrated one situation where WM hindered insight, but also proposed that task characteristics moderate the relationship, furthering these research goals. Here, we outline additional moderators and describe how some of these factors might explain differences between DeCaro et al. and Chuderski and Jastrzębski (2017). We argue that individual differences and situational factors interact to determine the extent to which executive control will be brought to bear on a given problem. Characteristics of the insight task then determine whether this level of control helps or hinders insight. Thus, the balance of these

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processes very likely depends on moderating factors. Scholars must reconcile these factors within a more unified account of problem solving (see also DeCaro, in press).

Individual Differences

Several individual difference factors impact the effectiveness with which executive control is allocated to problem solving. The most studied individual difference factor in the insight problem solving literature is WM capacity (WMC). WMC enables individuals to deliberately attend to and work with problem elements while inhibiting irrelevant or nonessential information (Engle, 2002). The preponderance of positive correlations in cognitive performance research (i.e., "positive manifold," Chuderski & Jastrzębski, 2017) has led to the widespread assumption that more WMC is better (cf. Hills & Hertwig, 2011).

Higher WMC enables solvers to more effectively represent the problem, search long-term memory for possible solutions, and focus on the problem goal (Chein & Weisberg, 2014). Higher capacity individuals are therefore better able, and thus more inclined, to use complex strategies to solve problems, which is sometimes beneficial (Beilock & DeCaro, 2007; Thomassin, Gonthier, Guerraz, & Roulin, 2015). However, individuals sometimes direct their attention to the wrong information, such as an incorrect problem representation or solution strategy. With higher capacity individuals, this process can lead to fixation, hindering insight (Wiley & Jarosz, 2012).

Expertise can generate similar effects, when prior experience leads a person to fixate on a "typical" but incorrect solution approach (Wiley, 1998; see also Bilalić, McLeod, & Gobet, 2010). However, other individual difference factors promote more flexible or adaptive applications of executive control (Collins & Koechlin, 2012). For instance, prior exposure to problems with "insightful" solutions can prime a more flexible approach (Siegler, 2000). In addition, bilingual individuals have been shown to more flexibly switch task representations, improving insight problem solving (Cushen & Wiley, 2011). Thus, factors that impact how individuals allocate executive control can lead different people to solve the same problem in different ways, moderating insight problem solving (cf. Chein & Weisberg, 2014; Fleck & Weisberg, 2013).

Individual differences may have moderated Chuderski and Jastrzębski (2017) and DeCaro et al.'s (2016) findings. First, DeCaro et al. excluded participants who self-reported prior knowledge of the problem solutions used in the study. In contrast, Chuderski and Jastrzębski acknowledged that some of the insight problems were popular in the media but did not exclude individuals based on prior experience. Second, whereas Chuderski and Jastrzębski included Polish university students, DeCaro et al. included university students from the United States. Base rates of bilingualism differ dramatically between these two locations. In Poland, around 50% of individuals report knowing another language (Special Eurobarometer 386, 2012), whereas in the U.S. only 21% report speaking another language (U.S. Census Bureau, 2013). In addition, it is a national requirement to study two foreign languages in Poland, beginning at age 7 (Eurostat, 2012). Most U.S. elementary schools do not teach foreign languages (Devlin, 2015). However, we have no information about bilingualism in the specific samples in these two studies. Chuderski and Jastrzębski noted that their participants performed matchstick arithmetic problems better than DeCaro et al.'s participants. This finding may indicate individual differences between these samples (e.g., experience, bilingualism); Chuderski and Jastrzebski's sample appears to be more flexible, and therefore may be able to more readily switch to associative processing when needed for the particular task.

Situational Factors

Situational factors can also influence how executive control is allocated, impacting insight problem solving. Situations that disrupt executive control (e.g., dual-task conditions) sometimes hinder insight (e.g., Ball & Stevens, 2009; but see Ball et al., 2015). More commonly, insight improves in situations that compromise executive control. For example, insight problem solving improves during one's nonoptimal time of day (Wieth & Zacks, 2011), under moderate alcohol intoxication (Jarosz et al., 2012), when in a positive mood state (associated with less analytic thought; Gasper, 2003), and following focal damage to the lateral frontal cortex (Reverberi et al., 2005). Reduced insight has also sometimes (but not always) been observed in situations where executive control is increased, rather than decreased (Ball et al., 2015; Schooler, Ohlsson, & Brooks, 2003; Van Stockum & DeCaro, 2014; but see, e.g., Ball & Stevens, 2009; Fleck & Weisberg, 2004, 2013). Many of these situational factors interact with individual difference factors. For example, in a distracting high-pressure situation, higher WMC is coopted, and insight is improved (Beilock & DeCaro, 2007).

Characteristics of the Insight Task

Studies examining the impact of WM on insight must therefore consider how individual differences and situational factors jointly influence how executive control is allocated during problem solving. However, whether greater executive control will help or hinder insight depends on characteristics of the insight task (DeCaro, in press). As discussed by DeCaro et al. (2016), insight problem solving is thought to proceed through three primary phases. First, solvers *represent* the problem, typically incorrectly. Then, solvers proceed through the *solution* phase, attempting to solve the problem in line with this incorrect representation before reaching an impasse. Then, solvers must *restructure* their initial representation. If restructured correctly, sudden insight is likely; if not, solvers' efforts may continue to be hindered by impasse (Ash & Wiley, 2006).

Insight problems tend to be distinguishable from noninsight problems (Gilhooly & Murphy, 2005). However, insight tasks vary widely, are not always solved via special processes, and different task phases may rely more or less on WM-demanding executive control processes. As shown in Table 1, WM will generally benefit the representation phase if solvers must interpret many problem statements or manage multiple task goals and sets of rules (e.g., word problems involving multiple scenarios; DeCaro et al., 2016; Gilhooly & Fioratou, 2009; Hambrick & Engle, 2003). Conversely, WM should be less important for tasks that place fewer demands on interpretation (e.g., matchstick arithmetic problems that have the same basic goals and directives; DeCaro et al., 2016). Similarly, WM should benefit the solution phase for insight tasks with many or complex solution possibilities that must be exhaus-

Table 1
Impact of Working Memory (WM) at Each Insight Problem Solving Phase

Impact of WM	Insight problem-solving phase: Representation	Solution	Restructuring
Beneficial	Problem interpretation imposes high WM demand	Many or complex solution possibilities	Analytical strategies are optimal
Neutral	Problem interpretation has low WM demand	Few or simple solution possibilities	Associative processes are optimal
Detrimental		Simple solution possibilities are required but complex solutions are used	Associative processes are optimal but analytical strategies are used

tively tested before reaching impasse. WM should be less critical with few or simpler solution possibilities to test (Ash & Wiley, 2006). WM should also benefit restructuring that is successfully accomplished by analytical search and retrieval strategies (cf. Weisberg, 2006). WM will be less likely to help restructuring that operates associatively, largely outside of executive control (Ash & Wiley, 2006). Overall associations with WM will be multiply determined by all three phases, the effects of which must be considered jointly. In the cases where WM is less impactful, we may expect to see neutral effects of WM on insight.

Higher WM will be detrimental when a phase is approached with more executive control, but simpler or associative processes are more optimal (see Table 1). For instance, WM-demanding strategies that entail exhaustive testing of multiple, or complex, solutions could preclude progress toward impasse and restructuring (Beilock & DeCaro, 2007). Higher WMC could also lead individuals to use WM-demanding analytical search and retrieval strategies during restructuring (Fleck & Weisberg, 2004; Weisberg, 2006), overshadowing more fruitful associative strategies (Wiley & Jarosz, 2012).

According to this initial framework, it is essential to characterize problem phases by their WM demand, and determine whether the WM available matches these demands. Success requires that higher WM be devoted only when necessary, such that WM-demanding strategies are not implemented when these will override more optimal simple or associative processes.

Other Task Characteristics

By identifying the involvement of WM at each phase, we are better able to predict how other elements of the insight task may change the WM-insight relationship. For example, Chuderski and Jastrzębski (2017) gave participants hints, or otherwise cued participants, that they should approach the problems in a “flexible and non-standard way” (see also Chein et al., 2010; Luchins, 1942). Higher WMC individuals are sensitive to such hints, and can selectively calibrate their strategies and attention when prompted to do so (Colflesh & Conway, 2007; Conway, Cowan, & Bunting, 2001). Solvers typically begin insight problems with an incorrect problem representation, which leads them down a wrong path. Higher WMC individuals may be more likely to adhere to that path when complex strategies appear viable (Beilock & DeCaro, 2007). But if primed for a more flexible approach, higher WMC individuals might spread their attention to more remote solution paths, facilitating insight (Colflesh & Conway, 2007). The ability to flexibly calibrate attention could be beneficial in any phase of insight problem solving by (a) reducing the chance of an initial incorrect representation, (b) reducing the tendency to persist when more complex solution strategies prove unviable, or (c) promoting restructuring using multiple approaches, whether WM-demanding and/or associative.

In Chuderski and Jastrzębski’s (2017) experiments, participants encountered multiple types of insight problems (matchstick and insight word problems) in a single session. Solving insight problems earlier in a session provides a cue to the nature of these problems, priming more flexible strategies (Siegler, 2000). As another example, DeCaro et al. (2016) gave solvers ample space to write their answers, potentially anchoring individuals to use complex strategies that utilize the space. In contrast, limited writing space (as in Chuderski & Jastrzębski’s, 2017, Experiment 1) could cue solvers that complex approaches are not needed.

How WMC Is Conceptualized and Measured

Given the central role ascribed to WM in the current debate, the way WMC is conceptualized and measured could be another crucial factor, changing both the findings and their theoretical interpretation. WMC measures differ in whether they primarily assess domain-specific (e.g., verbal, spatial) short-term storage or domain-general executive attention (i.e., the ability to maintain and manipulate information in the focus of attention). Complex span tasks (e.g., Reading Span, Operation Span, Symmetry Span) primarily assess the latter (Redick et al., 2012), and are well-validated and commonly used in insight research (e.g., Ash & Wiley, 2006; Chein & Weisberg, 2014; Gilhooly & Murphy, 2005; Ricks et al., 2007), including by DeCaro et al. (2016). Although these tasks are presented using either verbal or spatial stimuli, it is the domain-general variance that accounts for the predictive power of the WMC construct (Engle, 2002). Thus, use of verbal or spatial complex span tasks should lead to similar results (Redick et al., 2012).

Some studies use more than one measure, complex span or otherwise (e.g., Ash & Wiley, 2006; Beilock & DeCaro, 2007; Chein & Weisberg, 2014; Chuderski & Jastrzębski, 2017; DeCaro et al., 2016, Experiment 2; Fleck, 2008; Gilhooly & Murphy, 2005). Of these studies, some examine both domain-general and domain-specific aspects of WM (e.g., Chein & Weisberg, 2014), whereas others create a composite executive attention measure (e.g., Ash & Wiley, 2006; Beilock & DeCaro, 2007; DeCaro et al., 2016). Studies differ in how composites are calculated (e.g., averaging raw or standardized scores). Studies also sometimes include covariates in their analyses, such as attention measures (Chein & Weisberg, 2014; Gilhooly & Fioratou, 2009).

Chuderski and Jastrzębski (2017) used several, to our knowledge, unvalidated versions of the complex span tasks, limiting the ability to compare their assessments to more standardized approaches. To improve comparability across studies, researchers should adopt more standardized measurement and reporting practices (Redick et al., 2012).

Executive Control Versus Special Processes in Insight

In summary, DeCaro et al. (2016) and Chuderski and Jastrzębski's (2017) studies are two examples of a larger contradictory literature examining the impact of WM on insight problem solving. Chuderski and Jastrzębski conclude that "the special-process accounts are not tenable (at least in their radical form)," because "if solving such problems so strongly relies on WM, there can be little that is special about them" (2003). Our position does not represent a radical stance; DeCaro et al. explicitly stated that the effect of WM is context-specific. Moreover, such claims do not reflect the larger literature that finds support for special processes. In the current article, we embraced this contradictory literature as a sign of greater complexity in the insight process, and attempted to explain when, why, and for whom WM will help or hurt insight, comprehensively advancing theory. Problem solving is a multidimensional process, and cannot be divorced from context. Individual differences and situational factors interact to determine the executive control devoted to task performance, and insight will be supported if the executive control used matches that required in each phase of the insight task.

Chuderski and Jastrzębski (2017) argue that their insight problems must have had a "substantial analytic component" overall, presumably across insight stages. This argument may be accurate. However, we contend that unaccounted for individual differences or task characteristics that promote flexible thinking, such as experience, bilingualism, and use of multiple problem types, may have helped higher capacity individuals approach these tasks with greater flexibility, facilitating insight (cf. Colflesh & Conway, 2007).

Importance of "Less Is More" Studies and Replication

Replication studies are critical, but it is inappropriate to make blanket statements such as "people with less effective cognition are . . . *less* creative" (Chuderski & Jastrzębski, 2017, 2003) based on one failure to replicate—particularly when the study does not "precisely replicate" (Abstract) a procedure as claimed. Chuderski and Jastrzębski's Experiment 2A (the replication study) included many methodological differences from DeCaro et al. (2016): no participant exclusions based on prior experience, including both matchstick and traditional insight problems within the same study, testing participants in groups, using unvalidated WMC measures, and potentially a more bilingual sample. Their other two studies had additional differences: using different problems (including the critical CR problems), providing hints, giving extremely limited time and limited space to write answers, and not covarying incremental problem solving in their analyses. As discussed above, many of these factors could have moderated the results.

Chuderski and Jastrzębski (2017) inaccurately argued against the reliability of our "marginally-significant" results (1994), which were statistically significant at the conventional alpha level of 0.05. They stated that our findings for Experiment 2 may have resulted from "the distribution of insight problem solving composite score that deviated from the normal distribution" (1994), even though our insight scales were normally distributed (DeCaro et al., 2016, p. 45). We demonstrated the same pattern of findings across two studies. More important, our findings were consistent with converging evidence from a number of other studies, supporting the reliability of these effects (e.g., Ball et al., 2015; Beilock & DeCaro, 2007; Gasper, 2003; Jarosz et al., 2012; Reverberi et al., 2005; Van Stockum & DeCaro, 2014; Wieth & Zacks, 2011). Such sweeping conclusions therefore discount a substantial body of work demonstrating that less executive control can improve performance on many different tasks, including insight and creative problem solving (see Amer, Campbell, & Hasher, 2016; Bocanegra & Hommel, 2014; Chrysikou et al., 2014; DeCaro & Beilock, 2010; Hills & Hertwig, 2011; Munakata, Snyder, & Chatham, 2013; Wiley & Jarosz, 2012).

We must avoid mental set as a field, acknowledging that exceptions to the "positive manifold" offer important information about mechanisms underlying performance (Goschke, 2000). The interplay of individual differences, situational factors, and task characteristics may determine when individuals use and profit from WM-demanding or associative processes—leading them to display more or less creative insight.

References

Amer, T., Campbell, K. L., & Hasher, L. (2016). Cognitive control as a double-edged sword. *Trends in Cognitive Sciences, 20,* 905–915. http://dx.doi.org/10.1016/j.tics.2016.10.002

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

Ball, L. J., Marsh, J. E., Litchfield, D., Cook, R. L., & Booth, N. (2015). When distraction helps: Evidence that concurrent articulation and irrelevant speech can facilitate insight problem solving. *Thinking & Reasoning, 21,* 76–96. http://dx.doi.org/10.1080/13546783.2014.934399

Ball, L., & Stevens, A. (2009). Evidence for a verbally-based analytic component to insight problem solving. In N. Taatgen & H. J. van Rijn (Eds.), *Proceedings of the Thirty-First Annual Conference of the Cognitive Science Society* (pp. 1060–1065). Austin, TX: Cognitive Science Society.

Beilock, S. L., & Decaro, M. S. (2007). From poor performance to success under stress: Working memory, strategy selection, and mathematical problem solving under pressure. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33,* 983–998. http://dx.doi.org/10.1037/0278-7393.33.6.983

Bilalić, M., McLeod, P., & Gobet, F. (2010). The mechanism of the einstellung (set) effect: A pervasive source of cognitive bias. *Current Directions in Psychological Science, 19,* 111–115. http://dx.doi.org/10.1177/0963721410363571

Bocanegra, B. R., & Hommel, B. (2014). When cognitive control is not adaptive. *Psychological Science, 25,* 1249–1255. http://dx.doi.org/10.1177/0956797614528522

Bowden, E. M., Jung-Beeman, M., Fleck, J., & Kounios, J. (2005). New approaches to demystifying insight. *Trends in Cognitive Sciences, 9,* 322–328. http://dx.doi.org/10.1016/j.tics.2005.05.012

Chein, J. M., & Weisberg, R. W. (2014). Working memory and insight in verbal problems: Analysis of compound remote associates. *Memory & Cognition, 42,* 67–83. http://dx.doi.org/10.3758/s13421-013-0343-4

Chein, J. M., Weisberg, R. W., Streeter, N. L., & Kwok, S. (2010). Working memory and insight in the nine-dot problem. *Memory & Cognition, 38,* 883–892. http://dx.doi.org/10.3758/MC.38.7.883

Chrysikou, E. G., Weber, M. J., & Thompson-Schill, S. L. (2014). A matched filter hypothesis for cognitive control. *Neuropsychologia, 62,* 341–355. http://dx.doi.org/10.1016/j.neuropsychologia.2013.10.021

Chuderski, A., & Jastrzębski, J. (2017). Working memory facilitates insight instead of hindering it: Comment on DeCaro, Van Stockum, and Wieth (2016). *Journal of Experimental Psychology: Learning, Memory, and Cognition, 43,* 1993–2004. http://dx.doi.org/10.1037/xlm0000409

Colflesh, G. J. H., & Conway, A. R. A. (2007). Individual differences in working memory capacity and divided attention in dichotic listening. *Psychonomic Bulletin & Review, 14,* 699–703. http://dx.doi.org/10.3758/BF03196824

Collins, A., & Koechlin, E. (2012). Reasoning, learning, and creativity: Frontal lobe function and human decision-making. *PLoS Biology, 10,* e1001293. http://dx.doi.org/10.1371/journal.pbio.1001293

Conway, A. R. A., Cowan, N., & Bunting, M. F. (2001). The cocktail party phenomenon revisited: The importance of working memory capacity. *Psychonomic Bulletin & Review, 8,* 331–335. http://dx.doi.org/10.3758/BF03196169

Cushen, P. J., & Wiley, J. (2011). Aha! Voila! Eureka! Bilingualism and insightful problem solving. *Learning and Individual Differences, 21,* 458–462. http://dx.doi.org/10.1016/j.lindif.2011.02.007

DeCaro, M. S. (in press). When does higher working memory capacity help or hinder insight problem solving? In F. Vallee-Tourangeau & L. Ball (Eds.), *Current Issues in Thinking and Reasoning*. Psychology Press.

DeCaro, M. S., & Beilock, S. L. (2010). The benefits and perils of attentional control. In M. Csikszentmihalyi & B. Bruya (Eds.), *Effortless attention: A new perspective in the cognitive science of attention and action* (pp. 51–74). Cambridge, MA: MIT Press. http://dx.doi.org/10.7551/mitpress/9780262013840.003.0003

DeCaro, M. S., Van Stockum, C. A., Jr., & Wieth, M. B. (2016). When higher working memory capacity hinders insight. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 42,* 39–49. http://dx.doi.org/10.1037/xlm0000152

De Dreu, C. K. W., Nijstad, B. A., Baas, M., Wolsink, I., & Roskes, M. (2012). Working memory benefits creative insight, musical improvisation, and original ideation through maintained task-focused attention. *Personality and Social Psychology Bulletin, 38,* 656–669. http://dx.doi.org/10.1177/0146167211435795

Devlin, K. (2015). *Learning a foreign language a 'must' in Europe, not so in America*. Washington, DC: Pew Research Center. Retrieved from http://www.pewresearch.org/fact-tank/2015/07/13/learning-a-foreign-language-a-must-in-europe-not-so-in-america/

Dietrich, A., & Kanso, R. (2010). A review of EEG, ERP, and neuroimaging studies of creativity and insight. *Psychological Bulletin, 136,* 822–848. http://dx.doi.org/10.1037/a0019749

Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science, 11,* 19–23. http://dx.doi.org/10.1111/1467-8721.00160

Eurostat. (2012). *Key data on teaching languages at school in Europe*. Retrieved from http://ec.europa.eu/eurostat/documents/3217494/5775673/EC-XA-12-001-EN.PDF/917d3746-886e-456a-8b01-1971013d1cef

Fleck, J. I. (2008). Working memory demands in insight versus analytic problem solving. *The European Journal of Cognitive Psychology, 20,* 139–176. http://dx.doi.org/10.1080/09541440601016954

Fleck, J. I., & Weisberg, R. W. (2004). The use of verbal protocols as data: An analysis of insight in the candle problem. *Memory & Cognition, 32,* 990–1006. http://dx.doi.org/10.3758/BF03196876

Fleck, J. I., & Weisberg, R. W. (2013). Insight versus analysis: Evidence for diverse methods in problem solving. *Journal of Cognitive Psychology, 25,* 436–463. http://dx.doi.org/10.1080/20445911.2013.779248

Gasper, K. (2003). When necessity is the mother of invention: Mood and problem solving. *Journal of Experimental Social Psychology, 39,* 248–262. http://dx.doi.org/10.1016/S0022-1031(03)00023-4

Gilhooly, K. J., & Fioratou, E. (2009). Executive functions in insight versus non-insight problem solving: An individual differences approach. *Thinking & Reasoning, 15,* 355–376. http://dx.doi.org/10.1080/13546780903178615

Gilhooly, K. J., & Murphy, P. (2005). Differentiating insight from non-insight problems. *Thinking & Reasoning, 11,* 279–302. http://dx.doi.org/10.1080/13546780442000187

Goschke, T. (2000). Intentional reconfiguration and involuntary persistence in task set switching. In S. Monsell & J. Driver (Eds.), *Control of cognitive processes: Attention and performance XVIII* (pp. 331–355). Cambridge, MA: MIT Press.

Hambrick, D. Z., & Engle, R. W. (2003). The role of working memory in problem solving. In J. E. Davidson & R. J. Sternberg (Eds.), *The psychology of problem solving* (pp. 176–206). London, England: Cambridge Press. http://dx.doi.org/10.1017/CBO9780511615771.007

Hills, T., & Hertwig, R. (2011). Why aren't we smarter already: Evolutionary trade-offs and cognitive enhancements. *Current Directions in Psychological Science, 20,* 373–377. http://dx.doi.org/10.1177/0963721411418300

Jarosz, A. F., Colflesh, G. J. H., & Wiley, J. (2012). Uncorking the muse: Alcohol intoxication facilitates creative problem solving. *Consciousness and Cognition, 21,* 487–493. http://dx.doi.org/10.1016/j.concog.2012.01.002

Luchins, A. S. (1942). Mechanization in problem solving: The effect of Einstellung. *Psychological Monographs, 54,* 1–95. http://dx.doi.org/10.1037/h0093502

Munakata, Y., Snyder, H. R., & Chatham, C. H. (2013). Developing cognitive control: The costs and benefits of active, abstract representations. In P. D. Zelazo & M. D. Sera (Eds.), *Developing cognitive control processes: Mechanisms, implications, and interventions* (pp. 21–54). West Sussex, England: Wiley. http://dx.doi.org/10.1002/9781118732373.ch3

Redick, T. S., Broadway, J. M., Meier, M. E., Kuriakose, P. S., Unsworth, N., Kane, M. J., & Engle, R. W. (2012). Measuring working memory capacity with automated complex span tasks. *European Journal of Psychological Assessment, 28,* 164–171. http://dx.doi.org/10.1027/1015-5759/a000123

Reverberi, C., Toraldo, A., D'Agostini, S., & Skrap, M. (2005). Better without (lateral) frontal cortex? Insight problems solved by frontal patients. *Brain: A Journal of Neurology, 128,* 2882–2890. http://dx.doi.org/10.1093/brain/awh577

Ricks, T. R., Turley-Ames, K. J., & Wiley, J. (2007). Effects of working memory capacity on mental set due to domain knowledge. *Memory & Cognition, 35,* 1456–1462. http://dx.doi.org/10.3758/BF03193615

Schooler, J. W., Ohlsson, S., & Brooks, K. (1993). Thoughts beyond words: When language overshadows insight. *Journal of Experimental Psychology: General, 122,* 166–183. http://dx.doi.org/10.1037/0096-3445.122.2.166

Siegler, R. S. (2000). Unconscious insights. *Current Directions in Psychological Science, 9,* 79–83. http://dx.doi.org/10.1111/1467-8721.00065

Special Eurobarometer 386. (2012). *Europeans and their languages*. Retrieved from http://ec.europa.eu/public_opinion/archives/ebs/ebs_386_en.pdf

Thomassin, N., Gonthier, C., Guerraz, M., & Roulin, J. L. (2015). The hard fall effect: High working memory capacity leads to a higher, but less robust short-term memory performance. *Experimental Psychology, 62,* 89–97. http://dx.doi.org/10.1027/1618-3169/a000276

U.S. Census Bureau. (2013). *Language statistics: American Community Survey (2013)*. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_1YR_S1601&prodType=table

Van Stockum, C. A., Jr., & DeCaro, M. S. (2014). Enclothed cognition and controlled attention during insight problem solving. *The Journal of Problem Solving, 7,* 73–83. http://dx.doi.org/10.7771/1932-6246.1164

Weisberg, R. W. (2006). *Creativity: Understanding innovation in problem solving, science, invention, and the arts*. Hoboken, NJ: Wiley.

Wieth, M. B., & Zacks, R. T. (2011). Time of day effects on problem solving: When the non-optimal is optimal. *Thinking & Reasoning, 17,* 387–401. http://dx.doi.org/10.1080/13546783.2011.625663

Wiley, J. (1998). Expertise as mental set: The effects of domain knowledge in creative problem solving. *Memory & Cognition, 26,* 716–730. http://dx.doi.org/10.3758/BF03211392

Wiley, J., & Jarosz, A. (2012). Working memory capacity, attentional focus, and problem solving. *Current Directions in Psychological Science, 21,* 258–262. http://dx.doi.org/10.1177/0963721412447622

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