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BRIEF REPORTS

Overthinking skilled motor performance: Or why those who teach can't do

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Skilled athletes often maintain that overthinking disrupts performance of their motor skills. Here, we examined whether these experiences have a basis in verbal overshadowing, a phenomenon in which describing memories for ineffable perceptual experiences disrupts later retention. After learning a unique golf-putting task, golfers of low and intermediate skill either described their actions in detail or performed an irrelevant verbal task. They then performed the putting task again. Strikingly, describing their putting experience significantly impaired higher skill golfers' ability to reachieve the putting criterion, compared with higher skill golfers who performed the irrelevant verbal activity. Verbalization had no such effect, however, for lower skill golfers. These findings establish that the effects of overthinking extend beyond dual-task interference and may sometimes reflect impacts on long-term memory. We propose that these effects are mediated by competition between procedural and declarative memory, as suggested by recent work in cognitive neuroscience.

> Whether you're a world-class player or a weekend enthusiast, improving your golf game begins with your mind. You may be amazed to discover what happens when you free yourself from overthinking your shots and let your unconscious mind play the game.
>
> Marlin Mackenzie (1990)

Anyone who has mastered a motor skill appreciates that describing the procedural knowledge underlying one's performance is, literally, easier said than done. Describing procedural knowledge is difficult with good reason. Abundant evidence from cognitive psychology and cognitive neuroscience indicates that procedural and declarative knowledge are supported by different representations and mediated by distinct underlying neural systems (e.g., Anderson, 1982; Fitts & Posner, 1967; Gabrieli, 1998; Keele & Summers, 1976). But if skilled athletes are to be believed, the relation between procedural and declarative knowledge may be considerably less than neutral: Reflecting consciously on what one knows about a skill often undermines its proper execution. Here, we examine this putative negative relationship. There is empirical evidence that attending to the components of a well-learned skill can impair concurrent performance (Beilock, Carr, MacMahon, & Starkes, 2002; Gray, 2004; Jackson, Ashford, & Norsworthy, 2006). Our claim is that the negative effects of overthinking are not limited to online distraction, but also reflect a longer term impact of verbalizing procedural skills on later execution. In particular, we claim that this pearl of conventional wisdom is linked, in part, to the phenomenon of verbal overshadowing.

The Verbal Overshadowing Effect

There is a precedent for the hypothesis that verbalizing ineffable perceptual experiences impairs later retention. Schooler and Engstler-Schooler (1990) observed that participants who described a difficult-to-verbalize stimulus (the face of a bank robber) from memory were much worse at later recognizing that face than were participants who did not put their memory into words. This effect was termed *verbal overshadowing*, on the basis of the idea that verbalization creates a language-based representation that overshadows difficult-to-verbalize aspects of the perceptual memory. The phenomenon occurs when the details of a perceptual experience exceed what can be conveyed in words. For easy-to-verbalize tasks, such as recalling a spoken statement (Schooler & Engstler-Schooler, 1990) or logical problem solving (Schooler, Ohlsson, & Brooks, 1993), verbalization does not impede and, in some cases, facilitates mem-

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ory. Disruption occurs only when individuals attempt to describe memory for a stimulus with indescribable qualities. Verbal overshadowing has been observed in such domains as taste (Melcher & Schooler, 1996), audition (Houser, Fiore, & Schooler, 2003), map memory (Fiore & Schooler, 2002), and insight problem solving (Schooler et al., 1993), establishing that the effect is not limited to visual memories per se.

Verbal description does not always impair memories for perceptual experiences, however. For instance, Melcher and Schooler (1996) found that verbal overshadowing depends on one's relative perceptual and verbal expertise in a domain. In a study of wine drinkers, only those at an intermediate skill level recognized a previously sampled wine less accurately after describing it, suggesting that impairment occurs only when perceptual expertise outstrips verbal expertise. In a later study (Melcher & Schooler, 2004), participants received either perceptual or conceptual training on recognizing types of mushrooms, after which they described a target mushroom from memory. Importantly, verbal description impaired later recognition of the target mushroom only for participants who had received perceptual training.

When the verbal overshadowing effect was first reported, it was thought that verbalization impaired memory by leading participants to rely on memory for their generated descriptions during the test. If participants misremembered an aspect of a person's appearance while describing that person, the error might persist and distort later memory. This recoding interference account is consistent with findings that the contents of a verbal description can influence the likelihood of misremembering. For example, warning participants only to describe details that they can confidently recall (Meissner, Brigham, & Kelley, 2001) or providing participants with the names that they generated at encoding for hard-to-name forms (Brandimonte & Collina, 2008) have been shown to enhance subsequent memory accuracy.

However, several findings suggest that other mechanisms must contribute to verbal overshadowing effects. First, there is often little relationship between description accuracy and verbal overshadowing (Fallshore & Schooler, l995; Schooler & Engstler-Schooler, 1990; however, see Meissner et al., 2001). Second, describing a different face (Dodson, Johnson, & Schooler, 1997) or even describing a car (Westerman & Larsen, 1997) can impair later recognition of a target face. These findings led to an alternate view that verbal overshadowing reflects a shift in the type of processing used to recognize a perceptual stimulus. Specifically, the effect may reflect a change from the normal configural processing mode engaged during encoding to conscious, feature-based processing during the test. By this transfer-inappropriate processing theory (Schooler, 2002; Schooler, Fiore, & Brandimonte, 1997), limits on what can be expressed with language lead participants to focus their descriptions on discrete features (e.g., eye color, size of the nose) while excluding perceptual relationships between stimulus components that normally support recognition. This might shift participants to a feature orientation that carries over to the test, disrupting the use of configural processes and, thus, recognition.

The Present Experiment

Verbalizing the ineffable clearly impairs episodic memory in many perceptual modalities. The processes underlying this phenomenon might also contribute to the tendency for conscious reflection to interfere with skilled action. Because procedural knowledge underlying a motor skill typically far exceeds what can be expressed verbally, describing memory for skilled performance might pose difficulties similar to describing a perceptual experience. If so, perhaps describing a skill will impair its retention. There is evidence consistent with this negative relationship between conscious reflection and skilled action. An important idea in skill acquisition research (Anderson, 1982; Fitts & Posner, 1967) is that development of expertise involves a shift from declarative memory representations that are easy to articulate to procedural knowledge that is difficult to put into words. One consequence of such a change is that performance might suffer when experts attend to the elementary steps of their proceduralized skill during execution (e.g., Baumeister, 1984; Beilock & Carr, 2001; Lewis & Linder, 1997). Consistent with this view, Beilock, Carr, et al. (2002) found that requiring experienced golfers to attend to a specific component of their swing impaired their performance in a putting task. Novices, by contrast, benefit from focusing attention on elements of skill execution (Beilock, Carr, et al., 2002) or the internal production of movement (Perkins-Ceccato, Passmore, & Lee, 2003; but see Wulf & Su, 2007). These examples all involve attention to a skill during its execution, however; it is unclear whether simply thinking verbally about a skill offline disrupts later skilled performance. If describing the manner in which a skill is executed impairs later performance of that skill, it would extend the verbal overshadowing phenomenon to the domain of procedural memory. Importantly, such a finding would demonstrate a new way in which overthinking hurts motor performance, reflecting effects on long-term retention instead of to dual-task interference.

To determine whether describing execution of a motor task disrupts later performance, we asked golfers of low and intermediate skill to perform a novel putting task. After achieving a criterion of three consecutive sinks, participants either described what they remembered of their putting or performed an irrelevant verbal task. Afterward, both groups performed the putting task again. If describing procedural knowledge impaired memory for the skill, the number of trials required to reachieve criterion should be greater for verbalizers than for nonverbalizers. If this effect was sensitive to the asymmetry between procedural and verbal skill, as in verbal overshadowing (cf. Melcher & Schooler, 1996), the higher skill golfers should be more disrupted by verbalization. Indeed, the lower skill group might benefit from verbalization, as suggested by work on skill-focused attention (Beilock, Carr, et al., 2002).

METHOD

Participants

Eighty undergraduates with golfing experience participated for course credit or for $7. Golfers' self-reported score for a nine-hole course fell between 40 and 60, a range indicated by local golf experts as a definition of low to intermediate skill. Eight participants were replaced due to their inability to achieve the learning criterion in the initial phase.

Materials

On a 10 × 3 ft indoor green, participants putted up a gradual incline to a 3-ft square platform raised 3 in. off the ground, in which a regulation-sized hole was located 6 ft from the starting mark. Identical right- and left-handed 48-in. putters were available to suit each participant's preference.

Design and Procedure

Forty participants each were randomly assigned to the verbalization and to the no-verbalization conditions. Within each condition, 20 participants were assigned to each of the lower and higher skill conditions on the basis of their self-reported nine-hole golf score.

In the learning phase, the putting task was explained, and all participants were allowed as many trials as necessary (within an unrevealed limit of 20 min) to reach the criterion of three consecutive on-target putts.

After learning, verbalizers spent 5 min writing a detailed description of how they performed the task. These participants were advised to think back to everything that they focused on while putting and were instructed to "record *every* detail that you can remember, regardless of how insignificant it may strike you." Control participants (nonverbalizers) performed a verbal distractor task for the same duration, providing valence ratings for words with no association to golfing. In the final test, all participants returned to the putting task, and were again allowed as many trials as needed to reach three consecutive on-target putts. The number of trials to reachieve the criterion was measured.

RESULTS

Importantly, the differing initial skill levels in our skill groups were validated by performance on the putting task and by self-reports of golfing experience. Higher skill participants putted with greater accuracy than did lower skill participants during learning [$F(1,78) = 3.83$, $p = .05$] and at test [$F(1,78) = 3.91$, $p = .05$]. They had more years of golfing experience [$F(1,78) = 7.85$, $p = .006$] and were more likely than lower skill participants to own golf clubs [$F(1,78) = 6.64$, $p = .02$], to have taken golf lessons [$F(1,78) = 4.30$, $p = .04$], or to have played on a golf team [$F(1,78) = 11.72$, $p < .001$]. Within each skill level, there were no differences in golf experience or in other demographic characteristics across the verbalization and no-verbalization conditions (see Table 1).

Learning Performance

Performance did not vary reliably between the verbalizers and nonverbalizers (overall or within expertise level), indicating that these groups were well matched on skill and on learning phase practice in number of putts ($M = 19.8$, $SD = 12.0$, for verbalizers; $M = 24.2$, $SD = 14.1$, for nonverbalizers).

Test Performance

Higher skill golfers showed a verbal overshadowing effect, with verbalizers requiring literally twice as many putts to reachieve the performance criterion ($M = 21.2$, $SD = 15.1$) than did nonverbalizers ($M = 10.6$, $SD = 9.8$) [$F(1,76) = 5.55$, $p = .02$]. Lower skill golfers, by contrast, benefited from verbalization ($M = 19.9$, $SD = 14.5$) compared with the nonverbalization condition ($M = 22.4$, $SD = 16.7$), though not reliably ($F < 1$). This difference across skill groups was significant, as reflected in a skill × verbalization interaction [$F(1,76) = 4.24, p < .05$] (see Figure 1). Thus, verbalization disrupted performance for higher skill, but not lower skill, golfers, mirroring expertise effects observed in the perceptual domain.

The impact of verbalization can also be quantified by evaluating how it affected learning. A tremendous volume of literature on skill learning predicts improvement with practice. Interestingly, for higher skill golfers, nonverbalizers cut the number of trials to reach criterion in half between learning ($M = 21.4$) and test ($M = 10.6$) [$F(1,76) = 6.52$, $p = .01$], whereas verbalizers showed a nonsignificant reversal between learning ($M = 19.5$) and test ($M = 21.2$) ($F < 1$). This difference in practice effects was significant only for higher skill golfers, as reflected in a verbalization × phase interaction [$F(1,38) = 4.71$, $p = .04$; $F < 1$ for lower skill golfers]. Thus, verbalization erased the ubiquitous benefits of practice for individuals with greater procedural expertise.

Characteristics of Verbalization Content

We compared the verbal descriptions generated by higher and lower skill golfers to address whether the content might

Table 1
Participant Demographics

	Verbalization		No Verbalization	
Measure	Higher Skill Level	Lower Skill Level	Higher Skill Level	Lower Skill Level
N	20	20	20	20
Mean age (years)	20.6	22.0	20.5	20.5
Gender (percent male)	85	80	85	80
Mean (±*SD*) number years golfing	8.7 ± 4.6	6.3 ± 5.5	8.7 ± 4.3	5.6 ± 2.6
Mean (±*SD*) 9-hole score	42.6 ± 3.0	56.2 ± 11.7	42.3 ± 3.2	52.9 ± 4.9
Mean (±*SD*) 18-hole score	87.3 ± 8.7	105.0 ± 14.8	84.6 ± 8.2	103.1 ± 10.2
Percent played on golf team	45	20	65	20
Percent taken golf lessons	65	50	75	45
Percent owning golf clubs	95	75	95	75

Note—No significant differences in demographics of verbalization versus no-verbalization participants.

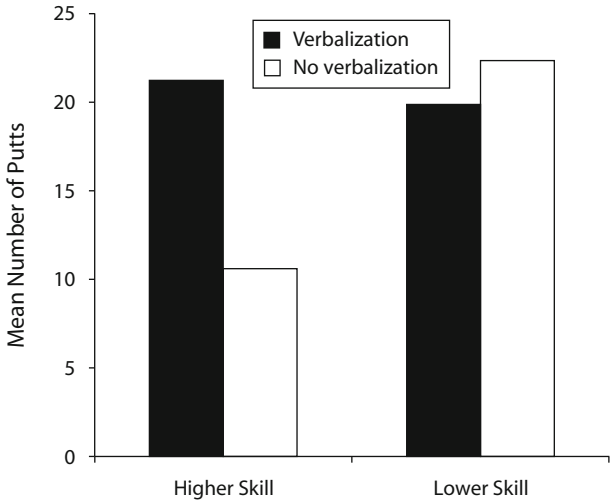

Figure 1. Test phase number of putts to reach criterion: Verbalization disrupts higher skill, but not lower skill, golfers' putting.

have differed noticeably across these groups (see Table 2). There were no reliable differences in length, nor in quantitative measures of readability or the number of putting steps described (determined by averaging counts from two independent raters, intraclass correlation of .94). Additionally, no significant differences across expertise level were found in qualitative details, which were coded for (1) descriptions of planning, execution, and outcome stages of putting (Beilock, Wierenga, & Carr, 2002) and (2) descriptions of putt execution having an internal (e.g., bodily movements) or external (e.g., movement effects) locus of attention (Wulf, Lauterbach, & Toole, 1999; Wulf & Prinz, 2001). It is unclear why we failed to find expertise differences in verbalization content akin to results from other paradigms (e.g., Beilock, Wierenga, & Carr, 2002). Perhaps the higher skill golfers in our study were not as experienced as the expert golfers used in previous work.

DISCUSSION

In the present experiment, we demonstrated that merely describing one's skilled motor performance could impair the execution of that skill later on. When higher skill golfers spent 5 min describing their recent putting experience, they took twice as many putts to reachieve the putting criterion on a later test than did control participants who spent 5 min performing an unrelated verbal activity. In contrast, lower skill golfers were not measurably affected by verbalization and, if anything, slightly benefited relative to lower skill control participants. This difference between higher and lower skill golfers appears unrelated to the amount or type of verbalization content. Thus, verbal description by itself does not impair skill execution, unless the performer possesses a higher degree of proceduralized knowledge. These results accord well with verbal overshadowing findings concerning episodic memory for perceptual experiences.

Although prior work has documented the negative effects of overthinking on motor performance, the present

Table 2
Summary of Verbalization Content Analysis

	Higher Skill Level		Lower Skill Level	
	M	*SD*	*M*	*SD*
Length of Verbalization				
Characters	701.0	146.9	683.9	155.9
Word count	139.5	29.4	137.5	32.6
Flesch Reading Ease	77.2	10.1	82.3	10.6
Beilock, Wierenga, and Carr (2002) Quantitative				
Number of putting steps described	5.9	2.0	6.1	2.2
Beilock, Wierenga, and Carr (2002) Qualitative				
Planning Content				
Characters	360.6	141.8	335.2	148.9
Percent total	52	16	47	17
Execution Content				
Characters	167.2	93.9	191.4	99.2
Percent total	24	12	29	17
Outcome Content				
Characters	105.3	77.8	91.7	78.3
Percent total	14	9	14	13
Nonprocess Commentary				
Characters	65.4	75.6	63.3	98.9
Percent total	10	12	10	16
Wulf: Internal/External				
Execution content				
Internal focus of attention (percent of verbalizations)	20	41	30	47
External focus of attention (percent of verbalizations)	45	51	50	51

Note—No significant differences between participants with higher versus lower skill level.

study is the first to demonstrate that such effects occur after thinking about performance offline. Whereas it may seem intuitive that consciously reflecting on one's skill during execution would cause dual-task interference, it is surprising that simply describing one's skill after the fact can be so disruptive. Indeed, our higher skill golfers were reduced to the performance level of our lower skill golfers after verbalizing for only 5 min. The observation of such offline impairment suggests new interpretations of previous work on dual-task interference in skilled performance, which previously would have been attributed to impaired execution resulting from competition for shared processes or capacity. Although the present findings do not negate such factors, they indicate that something more enduring may also occur: Conscious reflection may induce persisting changes in access to the underlying representations. Indeed, the prediction that such persisting effects might occur followed by analogy from the many instances of verbal overshadowing in episodic memory.

What produces this enduring impairment? One possible mechanism is global competition between modes of processing analogous to that proposed by the transfer-inappropriate processing hypothesis of verbal overshadowing (Schooler, 2002). In fact, research on learning systems in animals and humans suggests such a hypothesis, indicating that the neural systems mediating procedural and declarative learning competitively interact (Poldrack et al., 2001; Poldrack & Packard, 2003). For example, lesions to medial temporal lobe structures in animals improve procedural learning. Similarly, functional neuroimaging studies have shown that humans disengage medial temporal lobe activity after practice on a skill-learning task. If Poldrack and colleagues' hypothesis is correct, vigorously engaging declarative memory (as in a 5-min period of intensive verbal retrieval and description) should temporarily disrupt procedural learning systems. If so, the present effects may constitute the first behavioral evidence for the competitive learning systems hypothesis in humans. One intriguing prediction of this view is that verbal description should impair not only the described skill, but also other nondescribed skills acquired in the same session, much as verbally describing a face impairs retention of nondescribed faces (Dodson et al., 1997). Competition between explicit and implicit learning systems has also been investigated in categorization tasks that require integration of information according to rules that are difficult to verbalize (Maddox & Ashby, 2004). Such differential effects of rule-based and procedural learning have been suggested to contribute to "choking under pressure" (Markman, Maddox, & Worthy, 2006), which offers an interesting account of evidence that stressful situations can increase skill-focused attention in experienced athletes (Baumeister, 1984; Beilock & Carr, 2001; Gray, 2004).

A second explanation for our results is a residual disruptive effect of skill-focused attention prior to task execution. Verbalization required participants to focus attention on the elements of their skilled performance, similar to instructions to continuously monitor one component of a golf putting or soccer dribbling task in the study by Beilock, Carr, et al. (2002). In our study, as in that one, attention to the component actions (as must occur during the act of verbalization) hurt skilled participants' performance and modestly improved the performance of novices. Perhaps attending to the (verbalizable) components of a proceduralized skill induces enduring changes to the underlying representation by decompiling it into its constituent parts, as proposed by Masters (1992). Alternatively, verbalization may not affect the procedural representation, but may instead induce a lingering attentional bias toward the described components of the skill. Simply paying more attention to what one has just described may cause online interference during the final test session, yielding results like those observed by Beilock, Carr, et al. (2002). We must emphasize, however, that attention to the components of the skill by itself may not be enough; verbalizing memory for the action may be critical for impairing later performance. In the verbal overshadowing domain, related findings have shown, for example, that mental imagery of a perceptual stimulus is not sufficient to produce verbal overshadowing, implicating verbal processing as integral to this kind of memory error (Fiore & Schooler, 2002; Schooler & Engstler-Schooler, 1990).

Whatever the mechanistic basis, the present finding indicates that simply verbally expressing one's recent motor action may sow the seeds of poor execution during later performance. This observation may have repercussions for athletes, who depend on effective mental techniques to prepare for their events (e.g., implicit learning in a gymnastics routine can be disrupted by verbalization, as shown by Brandimonte, Coluccia, & Baldanza, 2008). Equally, sports coaches and other physical activity instructors may wish to reconsider their opinions on strategies for imparting knowledge about motor control. Whereas verbalization assists in the early stages of acquiring a skill, it may impede progress once an intermediate skill level is attained. To the extent that instructors themselves are skilled in what they teach, the recurring need to reflect upon and articulate the basis of their skill may pose costs to their performance. Indeed, unless a concentrated effort is made to maintain one's procedural expertise, the verbalization necessary for teaching may hasten a decline in skill, suggesting a new view of an old adage: Those who teach, cannot do.

AUTHOR NOTE

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REFERENCES

ANDERSON, J. R. (1982). Acquisition of a cognitive skill. *Psychological Review*, **89**, 369-406.

BAUMEISTER, R. F. (1984). Choking under pressure: Self-consciousness and paradoxical effects of incentives on skillful performance. *Journal of Personality & Social Psychology*, **46**, 610-620.

BEILOCK, S. L., & CARR, T. H. (2001). On the fragility of skilled perfor-

mance: What governs choking under pressure? *Journal of Experimental Psychology: General*, **130**, 701-725.

BEILOCK, S. L., CARR, T. H., MACMAHON, C., & STARKES, J. L. (2002). When paying attention becomes counterproductive: Impact of divided versus skill-focused attention on novice and experienced performance of sensorimotor skills. *Journal of Experimental Psychology: Applied*, **8**, 6-16.

BEILOCK, S. L., WIERENGA, S. A., & CARR, T. H. (2002). Expertise, attention and memory in sensorimotor skill execution: Impact of novel task constraints on dual-task performance and episodic memory. *Quarterly Journal of Experimental Psychology*, **55A**, 1211-1240.

BRANDIMONTE, M. A., COLUCCIA, E., & BALDANZA, F. (2008). *Talking about movement: Verbal overshadowing of motor learning*. Unpublished manuscript.

BRANDIMONTE, M. A., & COLLINA, S. (2008). Verbal overshadowing in visual imagery is due to recoding interference. *European Journal of Cognitive Psychology*, **20**, 612-631.

DODSON, C. S., JOHNSON, M. K., & SCHOOLER, J. W. (1997). The verbal overshadowing effect: Why descriptions impair face recognition. *Memory & Cognition*, **25**, 129-139.

FALLSHORE, M., & SCHOOLER, J. W. (1995). Verbal vulnerability of perceptual expertise. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **21**, 1608-1623.

FIORE, S. M., & SCHOOLER, J. W. (2002). How did you get here from there? Verbal overshadowing of spatial mental models. *Applied Cognitive Psychology*, **16**, 897-910.

FITTS, P. M., & POSNER, M. I. (1967). *Human performance.* Monterey, CA: Brooks/Cole.

GABRIELI, J. D. E. (1998). Cognitive neuroscience of human memory. *Annual Review of Psychology*, **49**, 87-115.

GRAY, R. (2004). Attending to the execution of a complex sensorimotor skill: Expertise differences, choking, and slumps. *Journal of Experimental Psychology: Applied*, **10**, 42-54.

HOUSER, T., FIORE, S. M., & SCHOOLER, J. W. (2003). *Verbal overshadowing of music memory: What happens when you describe that tune?* Unpublished manuscript.

JACKSON, R. C., ASHFORD, K. J., & NORSWORTHY, G. (2006). Attentional focus, dispositional reinvestment, and skilled motor performance under pressure. *Journal of Sport & Exercise Psychology*, **28**, 49-68.

KEELE, S. W., & SUMMERS, J. J. (1976). The structure of motor programs. In G. E. Stelmach (Ed.), *Motor control: Issues and trends* (pp. 109-142). New York: Academic Press.

LEWIS, B., & LINDER, D. (1997). Thinking about choking? Attentional processes and paradoxical performance. *Personality & Social Psychology Bulletin*, **23**, 937-944.

MADDOX, W. T., & ASHBY, F. G. (2004). Dissociating explicit and procedural-learning based systems of perceptual category learning. *Behavioral Processes*, **66**, 309-332.

MARKMAN, A. B., MADDOX, W. T., & WORTHY, D. A. (2006). Choking and excelling under pressure. *Psychological Science*, **17**, 944-948.

MASTERS, R. S. W. (1992). Knowledge, knerves, and know-how: The role of explicit versus implicit knowledge in the breakdown of a complex motor skill under pressure. *British Journal of Psychology*, **83**, 343-358.

MEISSNER, C. A., BRIGHAM, J. C., & KELLEY, C. M. (2001). The influence of retrieval processes in verbal overshadowing. *Memory & Cognition*, **29**, 176-186.

MELCHER, J. M., & SCHOOLER, J. W. (1996). The misremembrance of wines past: Verbal and perceptual expertise differentially mediate verbal overshadowing of taste memory. *Journal of Memory & Language*, **35**, 231-245.

MELCHER, J. M., & SCHOOLER, J. W. (2004). Perceptual and conceptual training mediate the verbal overshadowing effect in an unfamiliar domain. *Memory & Cognition*, **32**, 618-631.

PERKINS-CECCATO, N., PASSMORE, S. R., & LEE, T. D. (2003). Effects of focus of attention depend on golfers' skill. *Journal of Sports Science*, **21**, 593-600.

POLDRACK, R. A., CLARK, J., PARÉ-BLAGOEV, E. J., SHOHAMY, D., CRESO MOYANO, J., MYERS, C., & GLUCK, M. A. (2001). Interactive memory systems in the human brain. *Nature*, **414**, 546-550.

POLDRACK, R. A., & PACKARD, M. G. (2003). Competition among multiple memory systems: Converging evidence from animal and human brain studies. *Neuropsychologia*, **41**, 245-251.

SCHOOLER, J. W. (2002). Verbalization produces a transfer inappropriate processing shift. *Applied Cognitive Psychology*, **16**, 989-997.

SCHOOLER, J. W., & ENGSTLER-SCHOOLER, T. Y. (1990). Verbal overshadowing of visual memories: Some things are better left unsaid. *Cognitive Psychology*, **22**, 36-71.

SCHOOLER, J. W., FIORE, S. M., & BRANDIMONTE, M. A. (1997). At a loss from words: Verbal overshadowing of perceptual memories. In R. L. Goldstone, G. Schyns, & D. L. Medin (Eds.), *The psychology of learning and motivation* (Vol. 37, pp. 291-340). San Diego: Academic Press.

SCHOOLER, J. W., OHLSSON, S., & BROOKS, K. (1993). Thoughts beyond words: When language overshadows insight. *Journal of Experimental Psychology: General*, **122**, 166-183.

WESTERMAN, D. L., & LARSEN, J. D. (1997). Verbal-overshadowing effect: Evidence for a general shift in processing. *American Journal of Psychology*, **110**, 417-428.

WULF, G., LAUTERBACH, B., & TOOLE, T. (1999). The learning advantages of an external focus of attention in golf. *Research Quarterly for Exercise & Sport*, **70**, 120-126.

WULF, G., & PRINZ, W. (2001). Directing attention to movement effects enhances learning: A review. *Psychonomic Bulletin & Review*, **8**, 648-660.

WULF, G., & SU, J. (2007). An external focus of attention enhances golf shot accuracy in beginners and experts. *Research Quarterly for Exercise & Sport*, **78**, 384-389.

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