Developmental Review 34 (2014) 378–393

Contents lists available at ScienceDirect

Developmental Review

journal homepage: www.elsevier.com/locate/dr

Young children's transfer of strategies: Utilization deficiencies, executive function, and metacognition

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ARTICLE INFO

Article history:
Received 12 June 2014
Revised 26 October 2014
Available online 11 November 2014

Keywords:
Memory strategies
Cognitive transfer
Utilization deficiencies
Metacognition
Executive function

ABSTRACT

The purpose of this review is to present a new perspective on children's development of transfer of learning. The focus is on transfer of the effectiveness of a skill (i.e., improved performance), rather than just the transfer of the skill (e.g., a strategy) itself. Specifically, we examined the role of strategy utilization deficiencies, along with cognitive capacity, in the transfer of a memory strategy and, especially, strategy effectiveness (increased recall). Executive functions, metacognition, and mindset were considered as mechanisms that can both facilitate and hinder transfer of strategy effectiveness. Implications for theorizing about both transfer and utilization deficiencies were discussed.

Children's difficulties with transferring a new skill from the learning context to a new task or setting has been one of the thorniest problems facing both cognitive developmental and educational psychologists (e.g., Cox, 1997; Klahr & Chen, 2011; Salomon & Perkins, 1989). In research on children's memory strategy development, for example, it remains somewhat of a mystery why children trained to use a new memory strategy on one task often have such difficulty transferring it to another, seemingly similar, task or context, even a short time later, unless much aid is provided (e.g., Lange & Pierce, 1992; O'Sullivan & Pressley, 1984; Paris, Newman, & McVey, 1982; Ringel & Springer, 1980; see Pressley & Hilden, 2006 for a review). The issue of strategy transfer is important because no task or setting is

This article was written while Jérôme Clerc was a visiting research scholar at San Francisco State University, USA.

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http://dx.doi.org/10.1016/j.dr.2014.10.002
0273-2297/

exactly like the one in which the strategy is acquired, and thus children must overlook minor setting differences and see the relevance of the trained strategy in the new setting. The purpose of this paper is to provide a new perspective on strategy transfer by drawing on two literatures not previously directed toward the issue of transfer – strategy utilization deficiencies and executive functions. We also draw on relevant findings from research on children's mindsets about performance and children's metacognition that might identify processes involved in a utilization deficiency during transfer. We will show that even if a strategy is transferred well, its benefit on the task may not transfer. That is, a strategy that benefits performance on an initial task and is transferred to a second, similar task, may produce less benefit in that transfer task. We call this a transfer-utilization deficiency (t-UD), to distinguish it from the broader and more common use of the term utilization deficiency (UD), which refers to any situation in which an appropriate strategy is produced but provides little or no benefit (Miller & Seier, 1994).

We first discuss strategy transfer in children, focusing on the increased cognitive demand that typically occurs during transfer. Then we discuss how the construct of strategy utilization deficiency might clarify the difficulties of strategy transfer, and then summarize supporting results from previous research. Next, we show how the development of self-regulation, especially executive functions and metacognition, might lead to either increases or decreases in utilization deficiencies, depending on the child's developmental level. We also consider the possible role of mindsets during transfer. In the conclusion, we show the utility of bringing together the literatures on utilization deficiencies, executive function, and transfer to construct a more complete account of transfer during childhood.

Transfer of cognitive strategies in children

Cognitive transfer is a topic of great interest for developmental psychologists, as "Cognitive development would be impossible unless children could use what they learn in one context (both temporal and physical) when they encounter relevant tasks in another" (Klahr & Chen, 2011, p. 197). Indeed, transfer refers to the ability to re-use knowledge previously acquired in a situation, in a subsequent different situation, encompassing either different tasks or even sometimes trials of a different nature in the same task (a detailed account of transfer models is beyond the scope of this article but see Barnett & Ceci, 2002; Cox, 1997; Day & Goldstone, 2012; Salomon & Perkins, 1989, for reviews). What fundamentally defines transfer situations is the similarity-but-not-identity between tasks (Thorndike & Woodworth, 1901) and also between contexts (Klahr & Chen, 2011). Structural similarities (the causal chain in the logic for solving the task) are usually contrasted with surface similarities (superficial common features, such as in their appearance). Thus, the child must make an in-depth analysis of the essential structural and superficial qualities of both tasks (Chi & VanLehn, 2012). In other words, some similarities call for transfer and others do not (Gentner, Rattermann, & Forbus, 1993; Holyoak & Koh, 1987). Children therefore have to decide which, if any, similarities in the tasks call for transfer and then, if they decide to attempt transfer, actively adapt their previously acquired knowledge to the new task (Engle, Lam, Meyer, & Nix, 2012; Schwartz, Chase, & Bransford, 2012). In this way a child applies the unchanged-already known structure to a superficially different task.

A long history of research shows that transferring one's strategies is a common form of transfer in preschool- and school-aged children (Black & Rollins, 1982; Borkowski, Cavanaugh, & Reichhart, 1978; Borkowski, Levers, & Gruenenfelder, 1976; Carr, Kurtz, Schneider, Turner, & Borkowski, 1989; Clerc & Miller, 2013; Clerc & Rémy, 2014; Marchandise, Mansy-Dannay, Guerrien, & Clerc, 2014; Pressley & Dennis-Rounds, 1980), though sometimes not without difficulties (Crowley & Siegler, 1999; Rittle-Johnson, 2006). Difficulties when trying to transfer a strategy are likely to occur as a consequence of high resource-demanding processes. With regard to the above-mentioned analysis of each task, analyzing similarities between tasks and adapting the knowledge acquired in the first task to the second one involve processes that are highly resource-demanding. Especially demanding is the "knowledge compilation" mechanism involved in transfer, which "operates like a translation device, interpreting prior declarative knowledge into a set of procedures or cognitive rules to perform a specific task…[and]…can cause performance errors because of the working memory limitations that constrain how much declarative information can be retrieved" (Nokes-Malach & Mestre, 2013, p. 187). Researchers infer transfer from scores in the transfer task in measures such as recall (O'Sullivan & Pressley,