Far Transfer: Does it Exist?

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Abstract

Implementing interventions that are supposed to enhance students' general learning skill and overall cognitive ability is still a common practice in education. The basic idea on which this approach relies is that improving domain-general skills provides benefits for a broad range of domain-specific areas, such as academic disciplines. Thus, it is assumed that there is *far transfer* – i.e., the generalization of a set of skills between domains loosely related to each other. In recent years, chess instruction, music instruction, and working memory training have been claimed to be able to train domain-general abilities (e.g., fluid reasoning/intelligence) which, in turn, generalize to other cognitive and academic skills (e.g., mathematics). We tested these claims in the population of healthy children via meta-analysis. The results showed small to moderate overall far-transfer effects in all the outcome measures of the three meta-analyses. However, the effect sizes were inversely related to the design quality (e.g., presence of active control groups), which casts doubts on the effectiveness of the three activities. We discuss the theoretical and practical implications of these findings for education and expertise and extend the debate to another type of training, video games training.

Keywords: chess; education; learning; mathematics; music; transfer; working memory.

Introduction

The question of transfer is central to cognitive science. *Near transfer* can be defined as the generalization of a set of trained skills across domains closely related to each other. *Far transfer* can be defined as the generalization of a set of trained skills across domains loosely related to each other. Ever since Thorndike and Woodworth's (1901) *common elements* theory, psychology has documented the difficulty of far transfer. As noted by these authors, transfer from one domain to another can only happen when the two domains share common elements. Thus, while near transfer is expected to occur fairly often (e.g., transfer is expected between geometry and calculus), far transfer is much less likely, as the source and target domains share few elements (e.g., no transfer is expected between Latin and calculus).

The field of education has been much more sanguine about the possibility of far transfer. For example, in a very influential book, Papert (1980) argued that the skills acquired in learning the programming language LOGO would transfer to mathematics and indeed would improve learning generally. (Considerable research has shown that this was unlikely to be the case; e.g., Gurtner et al., 1990.) More recently, very strong claims have been made in educational quarters, on the web and in the popular press about the possible benefits of music, chess, and working memory training for improving academic achievements and a large variety of cognitive abilities (e.g., fluid intelligence, cognitive control, phonological processing, and spatial ability).

Recent Evidence

In recent meta-analyses (Sala & Gobet, 2016, 2017a, 2017b), we evaluated the evidence of transfer in three domains (chess, music, and working memory training). In all cases, we focused on healthy children and young adolescents.

The results showed null to medium overall effect sizes in all three meta-analyses. Moreover, the size of the effects was inversely related to the quality of the experimental design. Specifically, when the participants were randomly allocated to the groups and the experimental groups were compared to active control groups, the overall effect sizes were minimal or null.

Design quality thus accounts for the variability between the studies. The three treatments provide either minimal overall effects on academic achievement and overall cognitive ability (music and working memory training), or medium effects possibly due to placebo effects (chess) and/or statistical artefacts due to lack of randomization. Overall, these results support Thorndike and Woodworth's (1901) theory.

Link with Expertise Research

The lack of far transfer in these domains might appear surprising, because there is considerable evidence in these domains for correlations with intelligence and other intelligence-related measures. In a survey, Schellenberg (2006) reported medium correlations between time spent for music lessons and several measures of cognitive ability and academic attainment in a sample of children and undergraduate students. Similarly, Burgoyne et al. (2016) found that with chess players, the correlation between skill and fluid intelligence was $\bar{r} = .24$. Sala et al. (2017) found that chess players are more intelligent than individuals who do not play chess ($\bar{d} = 0.49$). Finally, the correlation between working memory and intelligence is about $r = .70$ (Kane, Hambrick, & Conway, 2005).

Of course, this evidence is correlational, and drawing conclusions about causality is notoriously difficult. Nevertheless, the pattern of results (near absence of far transfer in training studies and correlations with intelligence) suggests that, in the domains we have reviewed, intelligence comes first and explains why some individuals perform better than others.

We also note that the difficulty of far transfer is consistent with several theories of expertise. In particular, both chunking theory (Simon & Chase, 1973) and template theory (Gobet & Simon, 1996) propose that the development of expertise is closely linked to the acquisition of a large number of perceptual patterns. These patterns allow experts to memorise domain-specific material better than non-experts, even when the global structure of the material is destroyed by randomization (Sala & Gobet, 2017c). Accessing knowledge depends on productions matching these perceptual patterns. Thus, even if two domains share common elements at an abstract level, these two theories predict that far transfer is unlikely, as the perceptual patterns met in the two domains are different (Gobet, 2015, 2016; Gobet & Campitelli, 2006).

We are currently carrying out a meta-analysis of the effects of video game playing to further test these hypotheses. We strongly predict that near transfer will be common, but that far transfer will be rare. The results of this meta-analysis will be ready for the conference.

Implications for Education

The studies discussed above suggest that the widespread notion that practicing any cognitively demanding activity enhances one or more cognitive skills beyond the trained activity has little empirical support. In other words, the benefits of cognitive training seem to be, to a large extent, domain- and task-specific. Practically, the unlikely occurrence of far transfer suggests that the most effective way of improving a skill is to train that particular skill. This sobering conclusion should discourage educators and trainers from proposing curricula aimed at fostering domain-general skills. Rather, curricula and training programs with a considerable amount of domain-specific content should be preferred. Thus, if the aim is to teach mathematics, lessons focusing on mathematics are better than lessons containing material on music, chess or working memory training.

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