



Training spatial ability: Comment on Pietsch and Jansen (2012) and prospective research trends

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The ability to represent, manipulate and process spatial information is critical in a wide range of professional occupations, from surgeons to airplane pilots, mechanical engineers or financial analysts, to name a few (see for a review [Hegarty & Waller, 2005](#)). Aware of these demands, many higher-level institutions have rightfully included spatial psychometric tests in a growing number of curriculums, especially in science and engineering, to prepare prospective professionals to the challenges ahead.

However, quite surprisingly, the emphasis on spatial skills in elementary and high school curriculums remains sparse, possibly because spatial training seems inherently complex and does not rely on orthodox academic material. This is not to say that spatial thinking has been neglected by federal governments or local authorities. In the United States and in Europe, recent discussions involving experts in education and psychology have strongly encouraged taking effective measures to promote spatial thinking in early curriculums.¹ To some extent, the apparition of new technologies in the classrooms, via computer-based tools and instructions, has led to interesting methodological drifts in teaching, yet these initiatives remain rare and depend mostly on instructors' individual skills and preferences. Public and private institutions do have to follow reliable didactic functions, which may prevent them from hastily following research trends in teaching contents.

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¹ The report *Learning to Think Spatially* by the American National Research Council in 2005 urged governments to take action to promote spatial thinking in the K-12 curriculum, thus advocating a more central role for spatial skills in education.

Considering the eclectic functions of the educational system, this may well be legitimate. Perhaps the major role of primary and secondary education is to provide individuals with the basic tools that will allow smooth and efficient integration into society, thereby pushing aside spatial skills to promote the more urgent maturation of verbal processes. Although most educational systems already provide courses in sports and music, these might not be sufficient due to academic constraints, and students could benefit from participation in after-school activities. As such, spatial ability enhancement might also be the function of additional activities, outside regular educational systems. In that sense, sports and music, the two most popular extracurricular occupations among children, might provide exactly what schools cannot.

This is one of the many interesting points that can be drawn from the article by Pietsch and Jansen published in the February issue of *Learning and Individual Differences* ([Pietsch & Jansen, 2012](#)). The authors showed that individuals with a background in music or sports displayed significantly higher performance in a mental rotation task than individuals whose background was in education science. This finding is interesting, as it suggests the influence of these activities to promote enhancement of mental rotation, a particular spatial ability that has consistently yielded strong differences across individuals (see for a review [Voyer, Voyer, & Bryden, 1995](#)). In that regard, it follows the recent research that has demonstrated the efficiency of sport training ([Moreau, Clerc, Mansy-Dannay, & Guerrien, 2012](#)) and music expertise ([Brochard, Dufour, & Després, 2004](#)) in mental rotation enhancement, along with changes in cortical activity subsequent to a training program in these activities ([Jacini et al., 2009](#); [Stewart et al., 2003](#)), narrowing the traditional gap between practicing sports and playing a music instrument. After all, both types of activities require complex motor skill acquisition, to perform in a synchronized manner in space and time. The general implications of this idea in the field of education are far-reaching, pointing out that some of the very skills that will be critical in an individual's future benefit remarkably from after-school activities.

Moreover, spatial ability enhancement is only a restricted process within a large number of factors that are positively altered by these activities. The consequences of music or sport practice go well beyond spatial skill development, impacting domains such as health, social relations, psychological wellness, or self-esteem, thus allowing individuals to express themselves outside their usual environment. As such, extracurricular activities provide a suitable way to promote children's well-being in a broad and diverse manner.

Although the data Pietsch and Jansen report, based on a quasi-experimental design, do not provide direct experimental evidence

for the efficacy of sports and music programs, the paper deserves credit for investigating in a single study two fields that have provided similar results but have mainly been assessed separately. The next steps ought to precise a few critical points. First, research should determine to what extent training-induced improvements could generalize to different abilities within the spatial domain, besides mental rotation. Spatial ability is not a unitary construct (Linn & Petersen, 1985; McGee, 1979) and thus cannot be considered as a single factor, but rather as a set of different components that need to be assessed separately to refine our understanding of human cognition.

Following that point, there is a need to quantify the amount of practice required to display significant improvements. A large body of evidence has demonstrated the relationship between motor expertise and spatial performance, but some changes in spatial ability might appear at earlier stages of skill acquisition processes. Related to this idea, prospective research is needed to investigate the effect of programs targeting spatial skills as a function of developmental stages. Are the benefits from training constrained to specific age ranges, or do these extend to any individual? Obviously, these are extreme cases, and it is likely that results are somewhat more nuanced.

This leads to another important point: future studies should further define what underlying components within sport and music domains induce spatial ability enhancement. A plausible possibility is that an increase in working memory capacity could be underlying spatial ability improvements, as the two constructs have shown reliable correlations across individuals (Kaufman, 2007). Because of the recent surge of interest in working memory training (see for a review Shipstead, Redick, & Engle, 2012), this relationship is of fundamental importance to further understand the role of spatial processes in cognition.

Recent work also suggests that the motor demands of these activities might play a substantial role in higher cognitive processes (see for a review Beilock, 2009), in line with research in the expanding embodied cognition paradigm. The central idea of this approach is that the motor system and the so-called 'higher' processes are intertwined, thus influencing each other beyond their primary function. In this fashion, there is growing evidence that the degree of motor involvement in reasoning tasks depends on prior sensorimotor experience. For example, recent work has shown that expertise in sport triggers the involvement of motor processes in mental rotation tasks that normally tap into visual processes (Moreau, 2012). Here again, assessing individual differences is critical in providing a complete model of spa-

tial cognition accounting for interindividual variance, as individuals may greatly differ in the way they process information to perform a given task. In the exciting perspective of training spatial ability, a differential approach not only points out relevant variations across individuals but also refines our comprehension concerning the cognitive constructs per se, via the demonstration of associations or dissociations among constructs (Vogel & Awh, 2008). In that regard, carefully designed experiment, with fully controlled conditions comparing sport, music and more conventional spatial skill training will bring a great deal of knowledge to a rapidly growing field of research.

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