

Mental associations between numbers and space before school education

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Summary

Adult participants raised in Western societies associate small numbers with the left side in space and large numbers with the right side in space. The direction of this spatial-numerical association (SNA) might reverse or become attenuated in subjects with opposite reading habits (e.g., right-to-left in Arab cultures). Although cross-cultural variation of SNA indicates that spatial-numerical link is largely based on cultural literacy experience, recent developmental data have suggested that origins of this link might actually date back to preliterate periods of life. So far, it has not been clarified how numbers could be linked to spatial directions in subjects who lack explicit literacy training. The current thesis aimed to fill this gap in the SNA research. One theoretical and four empirical studies presented here examined main characteristics and determinants of number-space processing in preschool children (aged between 3 and 5 years) and adults, by using different methodologies (e.g., experimental tasks based on counting objects, counting fingers or comparing numerosities; theoretical examination and classification of different SNA effects). Several novel findings were established. First, number-space associations can be induced in preschool children by involving them in simple spatially oriented activities without any reading and numerical content. This result clearly shows that not only reading practice, which is available to older children and adults, but also other forms of consistent spatial training, feasible already to younger subjects, might serve as a good basis for number-space processing. Another finding seems to complement this picture: early knowledge about script convention – which was postulated by many authors as the most plausible source of preliterate SNA – was not well pronounced in preschool children and did not appear to be important for emergence of their number-space associations. Apart from the observed relation between SNA and early spatial experience, the current work points to importance of a certain kind of body-related constraints - ipsilateral tendencies in executing manual tasks – which mostly influences the direction of counting. Furthermore, by studying number-space associations in adults, it was observed that a particular form in which non-symbolic magnitudes are linked to space changes substantially over development, which could possibly reflect the process of symbolic numbers' acquisition. Finally, all the studies presented in this thesis jointly supported the view that number-space associations are not a unitary phenomenon but can emerge in preschool children in different forms; those different forms of SNA might develop based on partially different mechanisms. The current work culminates in proposing a theoretical model that integrates multiple sorts of endo- and exogenous factors potentially important for SNA emergence at the beginning of a postnatal life as well as for its further development.