An Evaluation of Neurogames®: A Collection of Computer Games Designed to Improve Literacy and Numeracy

Misbah Mahmood Khan, University of Hertfordshire, UK

Jonathan Reed, Neurogames, UK

ABSTRACT

Games Based Learning needs to be linked to good learning theory to become an important educational intervention. This study examines the effectiveness of a collection of computer games called Neurogames®. Neurogames are a group of computer games aimed at improving reading and basic maths and are designed using neuropsychological theory. The effectiveness of Neurogames was assessed using a matched pairs experimental design. Short exposure to Neurogames resulted in a significant increase in mathematical ability compared to control. The games resulted in a significant increase in reading ability. The study shows that brief exposure to computer games can result in significant changes to academic development. The implications for education and further research are discussed.

Keywords: *Computer Games, Education, Games Based Learning, Intervention, Literacy, Neurogames, Neuropsychology, Numeracy, Phonological Awareness*

INTRODUCTION

In order for Games Based Learning to develop as an important educational intervention it needs to be tied to good theories of learning and shown to be empirically effective. There is increasing interest in the use of computer games in education, known as Games Based Learning (Gee, 2003; Howard-Jones, 2009; Mitchell & Savill-Smith, 2004). This is because many children use computer games in their everyday life and are used to computer-based interfaces. Interest in computer games in education is also occurring because computer games are believed to be motivating (Whitton, 2007; Howard-Jones, 2009). Many children do not find education intrinsically motivating and therefore using computer games may help to motivate. Active participation, intrinsic and prompt feedback, challenging but achievable goals and a mix of uncertainty and open-endedness all contribute to the motivational dimension of these games (Mitchell & Savill-Smith, 2004). Computer games are typically fast and responsive, and provide a rich variety of graphic representations to generate a wide range of options and scenarios not possible with non-computer games (Prensky, 2001). In addition to these psychological motivating factors, playing video games has been shown to result in increased release of the neurotransmitter Dopamine, which is associated

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with reward and pleasure (Koepp et al., 1988). However not everyone who plays games finds them motivating (Whitton, 2007). Therefore it is important to build in explicit reward features to try and enhance motivation when designing educational based computer games.

Another potential benefit of computer game based learning is that it has the potential to provide a standardised, reliable and effective intervention. It should be possible to build in learning features to computer games so that they are delivered in an effective, reliable way. Unlike human teachers computer games provide the same responses, choices, and rewards each time they are played. This standardisation means that games should be capable of being scientifically evaluated. Through manipulation it should be possible to find the elements of teaching that are effective and build on these to increase efficiency. However despite this potential, so far there has been limited scientific evaluation of games on learning. For games based learning to develop effective intervention it needs to be tied to proven theories of learning (Gee, 2003).

The last ten years have seen an explosion of knowledge and research in the area of child neuropsychology, which is the study of children's brain, cognitive and psychological development (Reed & Warner Rogers, 2008). This is providing the basis for robust models of learning involving both neurological and psychological development. In particular very thorough theories of the development of reading and maths have been built (Goswami, 2008; Butterworth, 2005). Educational computer games could be designed to incorporate this knowledge.

In terms of reading there is strong evidence that the development of phonological understanding is important for the development of reading. When learning to read, it is necessary to phonologically decode words i.e., to work out (decode) the link between symbols (letters) and sounds (phonemes) (Goswami, 2008). Phonological decoding is based on phonological awareness. The onset of phonological awareness has been found to be a strong predictor of later reading in longitudinal studies (Bradley & Bryant, 1983). Training in phonological awareness results in higher levels of reading longitudinally, suggesting a causal relationship between phonological awareness and reading (Bradley & Bryant, 1983). The phonological structure of a language also seems to be important to reading acquisition. Differences in phonological structure account for differences in acquisition of reading across cultures (Ziegler & Goswami, 2005). In languages with simple consonant vowel phonological structure such as Italian, children in the first year at school were assessed to be 95% accurate in their Grapheme-Phoneme decoding skills. This contrasts with accuracy rates of 34% of children in Scottish schools learning to read the more phonologically complex English language (Seymore, Aro, & Erskine, 2003).

The importance of phonological awareness in the development of reading can also be at the brain level in the neuroimaging research literature. Phonological understanding develops in the left sided parieto-temporal region in the brain (Shawitz, 2003). Children with difficulties in phonological decoding (i.e., developmental dyslexia) seem to process reading on the opposite (right) side of the brain (Goswami, 2008). However it has been shown that with phonological training, children with reading difficulties can improve reading and restore function to the left side of the brain as seen on neuroimaging (Meyler et al., 2008).

Research into early years reading suggests that there is a sizable minority of children who continue to be below the expected standard in their development of reading. The Independent Review of the Teaching of Early Reading for the UK Government Department of Educational and Skills (Rose, 2006) reported that 19% of boys were not at the expected standard in terms of reading at stage 2 of the national curriculum. In line with the research literature reviewed here the report recommended that a more widespread phonics approach be implemented nationally. It concluded after a review of research and practice that "*'synthetic' phonics, offers the vast majority of young children the best and most direct route to becoming skilled readers and writers.*"