Human Movement Science 56 (2017) 29–36

Contents lists available at ScienceDirect

Human Movement Science

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

Full Length Article

Improvement in children's fine motor skills following a computerized typing intervention

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ARTICLE INFO

Keywords:
Dysgraphia
Typing intervention
Manual dexterity
Fine motor skills
MABC-2

ABSTRACT

Children spend a large proportion of their school day engaged in tasks that require manual dexterity. If children experience difficulties with their manual dexterity skills it can have a consequential effect on their academic achievement. The first aim of this paper was to explore whether an online interactive typing intervention could improve children's scores on a standardised measure of manual dexterity. The second aim was to implement a serial reaction time tapping task as an index of children's finger movement learning, and to see whether performance on this task would improve after the intervention. Seventy-eight typically developing children aged between 8 and 10 were tested at their school on the pre-intervention Movement Assessment Battery for Children (2nd edition; MABC-2) and tapping tasks. Twenty-eight of these children volunteered to be randomly allocated to the intervention or control group. Children in the intervention group had a choice of two online games to play at home over a period of four weeks, while the children in the control group were not given these games to play. The intervention and control groups were then re-tested on the MABC-2 manual dexterity and the tapping task. Children in the intervention group significantly improved their manual dexterity scores in the MABC-2 compared to the control group. On average, all children learnt the tapping sequence, however, there were no group differences and no effect of the intervention on the tapping task. These results have important implications for implementing a freely available, easy to administer, fun and interactive intervention to help children improve their manual dexterity skills.

1. Introduction

Daily activities for children require a variety of motor skills, which are developed and refined through practice (Ungerleider, Doyon, & Karni, 2002). This includes balance, coordination, fine and gross motor skills. Fine manual skills are essential for children at a school-aged level, and problems with these skills can affect children in diverse ways (McHale & Cermak, 1992). For instance, fine manual skills determine handwriting performance including speed and legibility (Exner, 1989; Simner, 1982). Handwriting performance can, in turn, determine a child's quality and quantity of learning and achievement in the classroom, and consequently have an influence on a child's self-esteem and motivation (Cermak & Henderson, 1990; Levine, Gordon, & Reed, 1987).

Fine motor difficulties can affect a child's academic performance because the child may attend to the mechanical aspects of written work instead of concentrating on the content of the work (May-Benson, Ingolia, & Koomar, 2002). Moreover, poor fine motor control is responsible for incorrect size or placement of letters, and inadequate pencil grip, which may result in slow, jerky writing

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http://dx.doi.org/10.1016/j.humov.2017.10.013
Received 15 December 2016; Received in revised form 16 October 2017; Accepted 19 October 2017

(Simner, 1982). Illegible handwriting can prevent the development of higher-order skills such as spelling and story writing (Feder & Majnemer, 2007). Children who have problems with fine motor skills are often fatigued by hand written school work, and often take much longer to complete their work (May-Benson et al., 2002). The consequences of fine motor difficulties resulting in poor handwriting, or dysgraphia – with a prevalence in school-aged children ranging from 10 to 30% (Karlsdottir & Stefansson, 2002), include a tendency towards lower achievement in mathematics, lower verbal IQ, and increased attentional difficulties (Sandler et al., 1992). Furthermore, children in junior school can spend up to 60% of their school day completing tasks that involve fine motor skills, and 80% of their time completing drawing and writing based tasks (McHale & Cermak, 1992). Due to the extent that impairments in fine motor skills can impact academic achievement in children, it is crucial that schools implement interventions for children with notable difficulties.

Previous research into motor interventions generally falls into one of two different approaches. The first approach is 'process-oriented', and focuses on the suspected underlying process of the motor deficit such as sensory functions, memory, attention, planning, and formulating motor programs (Laszlo & Bairstow, 1985; Laszlo, Bairstow, & Bartrip, 1988). The second approach is 'task-oriented', and involves remediation through the practice of a specific task that results in skill generalization (Schmidt, 1975). Task-orientated approaches focus on tasks that are causing the child difficulties (Henderson & Sugden, 1992; Revie & Larkin, 1993; Wright & Sugden, 1998). For the most effective intervention, occupational therapists and physiotherapists often adopt an eclectic approach, which combines elements of both process- and task-oriented methods. There is strong evidence to support both approaches, but the reason for their success is not clear (Sugden & Chambers, 2003). As the incidence of fine motor impairments is so high, it is important that other means of intervention or support are available, other than that from skilled professionals. Parents and teachers can also contribute to this intervention process, with research exploring developmental coordination disorder (DCD) finding that both teachers and parents can provide effective intervention for this motor condition, at home or at school respectively (Sugden & Chambers, 2003). Sugden and Chambers (2003) found that teachers and parents using a task-oriented intervention significantly improved scores on all sub-tests of the standardized Movement Assessment Battery for Children (2nd Edition; MABC-2) post intervention. Interestingly, although this intervention focused on one specific motor deficit, the children's overall motor performance increased, implying an underlying, more general, motor process was affected.

Occupational therapists, teachers, and parents alike have suggested using a computer word-processor with a keyboard as a solution to fine-motor difficulties in handwriting (Niles-Campbell, Tam, Mays, & Skidmore, 2008). However, evidence to support this recommendation in typically developing children is lacking (Klein et al., 2008). One of the few studies that do provide evidence for the use of word-processing to improve fine motor skills in typically developing children found that an intervention using computer software significantly improved 7–8 year old children's visual-motor skills (Chwirka, Gurney, & Burtner, 2002). The software used graphically presented hand and finger placement for each key, was self-paced, and had short lessons with visual reinforcers. Chwirka et al. (2002) commented that students were highly motivated to pursue this type of intervention because they enjoyed the use of a computer. The authors noted that keyboarding is not mechanically the same as handwriting, but there are similarities between the two activities, such that the practice of one may lead to improvement in the other (Chwirka et al., 2002).

The current study performed an intervention for improving fine motor skills. The first aim of this report was to test whether practicing typing skills with an interactive online game, similar to that used by Chwirka et al. (2002), could improve performance in children's fine motor skills. It was hypothesized that children in the intervention group would score significantly higher on the manual dexterity sub-tasks of the MABC-2 after the intervention period, compared to children in the control group who were not expected to significantly improve their score. We also tested performance on an abstract visual-motor tapping task, based on well-studied finger movement sequence learning tasks (Clegg, DiGirolamo, & Keele, 1998). This task is closely related to the intervention (i.e., requires sequential finger movements), is highly controllable, and completely novel to all the children. It was used both as an additional measure to assess children's fine motor skills in a way that is similar to the intervention, as well as to provide an index of children's finger movement learning skill. Therefore, the second aim of this study was to explore whether the performance on this tapping task improved after the intervention period. It was hypothesized that children in the intervention group would have a shorter reaction time and make fewer errors after the intervention period than children in the control group. It was also hypothesized that children would implicitly learn a finger movement sequence by having a shorter reaction time and perform fewer errors for a repeating sequence of movements compared to a random sequence of finger movements.

2. Method

2.1. Participants

All parents and children gave written, informed consent and assent, respectively. The experimental procedures were approved by the local ethical review committees at the University of Nottingham, and were in accordance with the Declaration of Helsinki (as of 2008).

Participants were recruited from an original sample of 78 children, recruited through their school in connection with a local DCD support group, and tested on the MABC-2 and tapping tasks. 65 children (24 males; mean ± SD age = 9.37 ± 0.73 years) were included in the sample for the tapping experiment, following exclusion of 13 participants determined by two criteria. The first criterion was for children to perform at least one correct tap in each set of eight trials per sequence, and the second was for children to have at least 62.5% correct responses (i.e., 5/8) in the pre-intervention test.

For the intervention phase, consent forms were sent out to all the 65 parents for their children to take part in the intervention, and 60 parents were also contacted by telephone. 28 consent forms were returned, allowing 28 children to participate in the post-