Applying Current Research Evidence into Practice: Development of a Handwriting Intervention Program

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Key Points:

Knowledge translation is key to putting evidence into practice.

Current evidence suggests that cognitive approaches are superior to multisensory approaches for handwriting remediation.

As a means to apply evidence to practice, a printing program was developed in parnership with a clinician and clinician scientist and is grounded in current research evidence and clinical experience.

Printing Like a Pro! is free to use and is accessible from http:/ www.childdevelopment.ca/School-Age_Therapy_Practice_Resources.aspx

In an article in this volume of the *Dyspraxia Foundation Professional Journal*, Zwicker (2011) reviewed the current state of the evidence for handwriting interventions. This article is an extension of this work by transferring this research knowledge into clinical practice. We first present a definition and model of knowledge translation, and then apply the model to create a handwriting intervention programme for use by therapists and educators in the school system. Based on current evidence and clinical experience, we created this resource to be freely accessible to those who wish to have an alternative intervention programme in their toolbox to assist children in learning how to print and in improving their handwriting legibility.

Knowledge Translation

Knowledge translation (KT) involves activities designed to close the gap between research and practice (Law and Baum, 1998). Since it can take up to 17 years for research to be translated into everyday practice (Balas and Boren, 2000, cited in Clancy and Cronin, 2005), the focus of KT is to ensure that "what is learned through research is shared rapidly in a focused and accessible manner so that practitioners are evidence-informed and so that clients benefit" (Law, Missiuna, and Pollock, 2008, p.3). KT facilitates the transfer of knowledge in a two-way exchange between those who develop the knowledge and those who will use the knowledge (CanChild, 2011). In this article, we would like to share how we put KT into action through our partnership with a clinician scientist who developed the knowledge (JGZ) and a clinician currently practising in a School-Age Therapy Programme (IM). We translated the research knowledge into a practical resource, which may be

considered an example of relatively swift diffusion of research findings into practice. We used the Diffusion of Innovations (DOI) theory (Rogers, 1995) to guide this process.

The Diffusion of Innovations Theory

The Diffusion of Innovations theory (DOI) (Rogers, 1995) identifies the processes and factors influencing the communication (diffusion) of an idea or practice, which is perceived as new (innovation). We selected this theory of knowledge translation because it has been identified as an applicable theory for knowledge translation in occupational therapy (Sudsawad, 2005; Colquhoun, et al., 2010).

As can be seen in Figure 1, there are five stages in the innovation-decision DOI process: Knowledge, Persuasion, Decision, Implementation and Confirmation. We will now describe how we used each of these stages to apply research evidence of handwriting interventions into clinical practice.

1. Knowledge Stage – "Learning of the existence of an innovation"
I (IM) first heard the occupational therapy researcher (JGZ) speaking about preliminary research results at a poster presentation during a Canadian Association of Occupational Therapists National Conference (Zwicker and Hadwin, 2005). The preliminary results of the study showed - in primary age students with handwriting difficulties - a cognitive approach (which is based on learning theories that involve
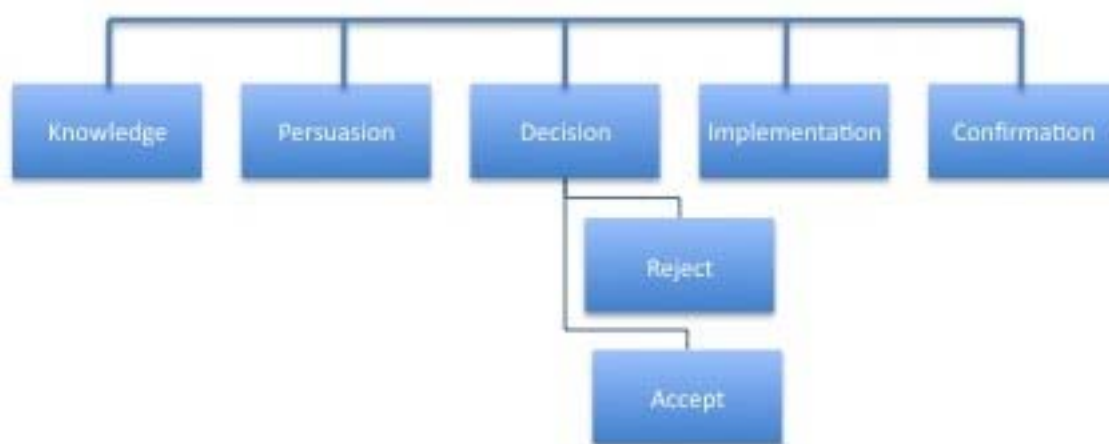

Figure 1. Five Stages in the Decision Innovation Process

self-instruction and verbal mediation) to be more effective in handwriting intervention than a multisensory approach (which uses sensory material and instruction). At that time, I was utilizing a multisensory printing programme that focused on teaching students with handwriting difficulties to print by learning the "feel" and motor pattern of a developmental sequence of letters. This was done through the use of sensori-motor instruction and materials, initially avoiding use of a pencil (i.e., using a finger to trace letters in rice on a cookie sheet). Once the student had practised the motor patterns in multisensory media, letter worksheets (with arrows indicating direction of

movement) were recommended in order to transfer onto paper the printing skills learned in the multisensory approach. It was these worksheets that I noted were utilized most frequently by school staff (often laminated for ease of reuse) with little compliance with multisensory activities.

2. Persuasion – "An opinion is formed of the innovation"
The research findings intrigued me, as they were congruent with my clinical observations in school-based practice. Within my practice, I had noted a longstanding issue of poor compliance implementing the multisensory approach in handwriting instruction. Recommendations that were focused on cognitive teaching strategies, such as the worksheets with directional arrows, were observed to be successful in remediating handwriting challenges in students with mild motor challenges and were most likely to be utilized by school staff. I found the research findings persuasive due to the relevance to typical school-based occupational therapy practice and the congruence with the type of suggestions most typically utilized by school staff. I felt that they could be easily applied to current school therapy practice.

3. Decision – "Activities are undertaken that lead to a choice of whether to adopt the innovation" – Acceptance.
This initial exposure to Zwicker's preliminary research findings precipitated me to conduct an extensive review of the literature on handwriting intervention. I gathered recently published studies in both the occupational therapy and educational psychology literature supporting cognitive interventions and cognitive-based handwriting instruction for the typically-developing school age population, as well as for children with a known diagnosis (Denton, Cope and Moser, 2006; Graham, 2009; Weintraub, Yinon, Bar-Effrat Hirsch and Parush, 2009; Zwicker and Hadwin, 2009; Mackay, McCluskey, and Mayes, 2010). These findings, paired with clinical observations, led to acceptance of a cognitive approach to handwriting intervention and incorporation of this into school-based practice.

4. Implementation – "The innovation is put to use"
I modified the multisensory printing programme that was currently being used in school-based consulting to focus on instruction using a cognitive approach. I then contacted the occupational therapy researcher to request a review of the modified printing programme. Together, we then shaped into practice, from the evidence based research and findings, an easy to access, use and implement printing practice resource (*Printing Like a Pro!*). The speed of development and success of this printing practice resource highlights the importance of two-way collaboration between those who develop the knowledge and those who will use the knowledge in the knowledge translation process.

5. Confirmation –"Activities are undertaken to confirm the decision about using the innovation"
There has been a lot of interest from school staff and local occupational therapists in the use of this programme in school-based settings. While initial feedback from school staff has been positive in terms of ease of use and success in improving printing legibility of students with mild motor challenges, research is needed to specifically evaluate the effectiveness of the *Printing Like a Pro!* programme.

A summary of the application of the DOI theory to the incorporation of research evidence of handwriting intervention into clinical practice is shown in Figure 2.
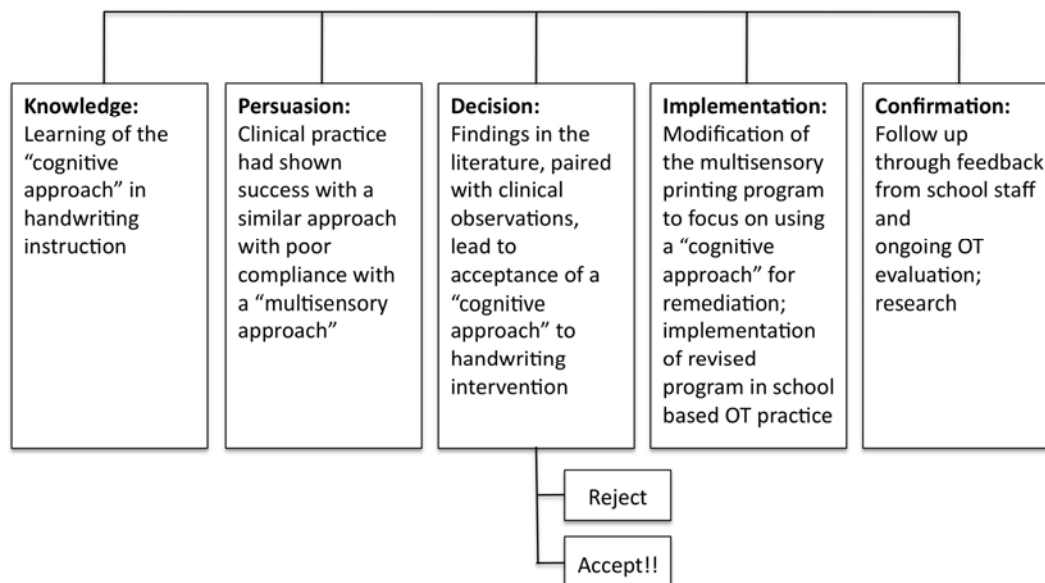
Knowledge:	Persuasion:	Decision:	Implementation:	Confirmation:
Learning of the "cognitive approach" in handwriting instruction	Clinical practice had shown success with a similar approach with poor compliance with a "multisensory approach"	Findings in the literature, paired with clinical observations, lead to acceptance of a "cognitive approach" to handwriting intervention	Modification of the multisensory printing program to focus on using a "cognitive approach" for remediation; implementation of revised program in school based OT practice	Follow up through feedback from school staff and ongoing OT evaluation; research

Reject

Accept!!

Figure 2. Application of the Decision Innovation Process

Development of *Printing Like a Pro!* Handwriting/Printing Programme:
A cognitive-based printing practice resource tool was developed from this knowledge translation process - *Printing Like a Pro!* (SunnyHill Health Centre for Children). It is designed for the "primary years" (especially Grade 2; ages 7-8 years) for students with mild motor impairments such as developmental coordination disorder, learning disabilities, and autism spectrum disorder. The goal of the *Printing Like a Pro!* printing programme is for students to learn how to write letters automatically, accurately and fluently, using efficient motor patterns.

This programme is designed to be utilized in a consultative model, implemented by school staff such as Resource Teachers or Special Education Assistants (SEAs or EAs), for one-to-one time (in classroom or pullout) or occasionally for small group work. *Printing Like a Pro!* is intended to be used as part of a comprehensive programme for students with handwriting challenges. This programme can be used in conjunction with adaptations, such as extra time for written work and decreased writing expectations. Also important are supportive classroom seating, positioning of paper, and use of pencil grips as needed. Inservicing to classroom teachers is also suggested, as this programme can be done by the entire class as part of their regular curriculum, with added practice time provided to students with known handwriting difficulties. Regular follow-up should be provided by the occupational therapist with a shift, as needed, to the use of technology, such as a word processing device or computer, in the upper elementary grades (ages 10-12 years) (Freeman, Mackinnon and Miller, 2005).

Printing Like a Pro! Specifics of Handwriting Instruction
Frequency and Duration

Teaching printing as a separate entity is recommended (Graham, Harris and Fink, 2000; Graham, 2009), as available research clearly indicates that students, especially those who struggle with handwriting, benefit from carefully planned, explicit handwriting instruction (Graham, 2009). Shorter, more frequent lessons are suggested, (Denton, Cope and Moser, 2006; Graham, 2009;) several times a week, or even daily, with 75 – 100 minutes a week devoted to handwriting instruction (Graham, 2009). A recent systematic review suggests that handwriting practice at least twice a week for 20 sessions is necessary to produce positive outcomes (Hoy, Egan and Feder, 2011).

Teaching Order of Case

Literature suggests that during handwriting instruction, students should learn lower case letter printing before upper case (Jones and Christensen, 1999; Graham, Harris and Fink, 2000; Berninger, Abbott, Augsburger and Garcia, 2009; Graham 2009; Zwicker and Hadwin, 2009). Lowercase letters are more frequent than capital letters in the text that students read and write (Berninger, et al., 2009). Except for proper nouns, only the first word of a sentence is capitalized; thus, overall, more lowercase letters are used in written sentences (Berninger, et al, 2009). Teaching lower case letters before upper case in handwriting instruction can help students in the long run to learn their "conventions" more solidly, i.e., proper capitalization and end punctuation.

Cognitive Instructional Features

The cognitive approach outlined in the programme includes several key features: modelling with visual cues, self-talk, self-evaluation and practice. The first feature - *instructional modelling with numbered arrows cues* – is utilized to provide a motoric model for the student to imitate (Berninger, et al., 1997). The numbered arrows show order and direction of stroke for each letter (Berninger, et al., 1997; Graham, Harris and Fink, 2000; Graham 2009; Zwicker and Hadwin, 2009). The numbered arrow cues allow students to create accurate representations of letter formation in memory (Berninger, et al., 1997).

While introducing each new letter, *modelling* letter formation using a chalkboard or white board is suggested (Graham and Weintraub, 1996; Graham, Harris and Fink, 2000; Graham, 2009; Weintraub, Yinon, Bar-Effrat Hirsch and Parush, 2009; Zwicker and Hadwin, 2009). While modelling, the teacher or therapist describes out loud the direction of movements. It is ideal if numbered arrows are included in the demonstration (Graham and Weintraub, 1996; Graham, Harris and Fink, 2000; Zwicker and Hadwin, 2009). Following this, the student should imitate the demonstration, followed by more copying practice (Graham, 2009; Zwicker and Hadwin, 2009). Tracing of each letter is not recommended as this does not encourage active learning of the motor pattern and instead focuses on pencil motor accuracy - i.e. the student's ability to stay on a line or to trace on a dotted line. Following practice, it is recommended to have the student cover their work and write the letter from memory (Berninger, et al., 1997; Graham, 2009; Zwicker and Hadwin, 2009). Automaticity depends on creating routines for retrieving letter formation from memory and that writing letters from memory helps construct these routines (Berninger, et al., 1997).

The second feature - s*elf-talk* - is a learning strategy to focus on metacognitive awareness via verbal mediation to guide letter formation (Zwicker and Hadwin, 2009). The student should be encouraged to verbalize proper letter formation/ direction of movement (Graham and Weintraub, 1996; Graham, Harris and Fink, 2000; Weintraub, Yinon, Bar-Effrat Hirsch and Parush, 2009; Zwicker and Hadwin, 2009). Use of self-talk can later be faded out as printing becomes more automatic, and should therefore be thought of as a temporary crutch (Graham and Weintraub, 1996).

The third feature - *self-evaluation* - encourages the student to learn to evaluate their work for increased awareness of components of legibility. It is important for the student to look at their printed letters to see how closely their letter formation matches the target letter (Graham and Weintraub, 1996; Jones and Christensen, 1999; Graham, Harris, and Fink, 2000; Weintraub, Yinon, Bar-Effrat Hirsch and Parush, 2009; Zwicker and Hadwin, 2009). The student should be encouraged to circle their best-formed letters based on set criteria (Graham 2009; Zwicker and Hadwin, 2009).

The fourth feature – *learning through repeated practice* – can be attained by use of a variety of fun writing implements including dry erase markers/white board, chalk/ chalk board, etc. to vary the task constraints (Graham and Weintraub, 1996; Denton, Cope and Moser, 2006; Weintraub, Yinon, Bar-Effrat Hirsch, and Parush, 2009) as well as the use of letter worksheets (Graham, Harris and Fink, 2000; Zwicker and Hadwin, 2009). The *Printing Like a Pro!* Programme includes letter worksheets that incorporate cognitive-based principles, i.e., numbered arrow cues, self-talk (outlined in a speech bubble), and self-evaluation.

Letter Worksheets
The letter worksheets in *Printing Like a Pro!* were created using a commercially based Fontware program (Educational Fontware, 2010). The worksheets were designed with "one letter per page" and are organized in a developmental progression of "letter groupings". Each group's letters are formed the same way and the letters in each group share common formational characteristics (Graham, 2009; Zwicker and Hadwin, 2009). Grouping letters with similar stroke patterns is thought to reinforce correct motor patterns for letter formation (Zwicker and Hadwin, 2009). Some letters can fit in more than one group so a clinical judgement was made regarding the best groupings. Letters that are easier to form are introduced before more difficult ones (Beery and Beery, 2004; Graham, 2009). If possible, they are ordered so that each letter motor pattern builds on the next and each letter grouping builds on the strokes learned in the previous group(s). Also, letters are grouped based on similar verbal self-talk strategies. Lastly, letters that could be easily confused or reversed are not in the same group, e.g., u and n or d and b (Graham, 2009). The sequence of letter groupings is outlined in Table 1 (lower case) and Table 2 (upper case).

Table 1. Developmental Groupings – Lower case

Group 1	**Downers**	**l i t f**
Group 2	**Rounders**	**c o e a d**
Group 3	**Curvers (special)**	**s u**
Group 4	**Curvers**	**r n m h b**
Group 5	**Diggers**	**j g q p**
Group 6	**Sliders**	**v w y x z k**

Table 2. Developmental Groupings – Upper case

Group 1	**Downers**	**L T I H F E**
Group 2	**Rounders**	**C O Q G**
Group 3	**Curvers (special)**	**S U J**
Group 4	**Curvers**	**P B R D**
Group 5	**Sliders (long)**	**V W X A N M Z**
Group 6	**Sliders**	**Y K**

As repeated practice will be necessary for students with handwriting challenges, it is recommended that the worksheets be reused by either laminating the letter worksheets or using page protectors with dry erase markers, dry erase crayons, or overhead pens (water soluble and non permanent – a damp paper towel is required for erasing). These writing implements do not "bleed" and have a true feel of "pencil drag" when used (especially the overhead pens). Thinner tips require more accuracy and are recommended for best accuracy in letter formation worksheet practice. To track a student's progress, work can be scanned and saved digitally before it is erased.

After each letter grouping is introduced it is ideal if the student can practise printing words that encompass letters learned for best carryover (Graham, Harris and Fink, 2000; Graham, 2009). Simple words should be used, encouraging the student to copy words that correspond to letters learned in each group. For example, in the "Downers" category, words such as "ill, it lit, tilt" etc. could be practised to reinforce letter formation and generalization to the printed word. To reinforce self-evaluation,

the student should again be directed to circle their best-formed word (Graham, Harris and Fink, 2000; Graham, 2009).

It is suggested that each lesson starts with a review or warm-up of previously learned letters, in order to reinforce all the motor patterns already learned, as these will be built on in the next set (Mackay, McCluskey, and Mayes, 2010). Documentation of which letters are tricky for the student is suggested. The student can then focus extra time on those letters (Graham, 2009; Zwicker and Hadwin, 2009).

Two versions were developed – one for School staff (Resource Teachers and SEA/ EAs) and one for Parents and Caregivers. By using the programme at both home and school, the student would be receiving consistent instruction and additional practice time.

The *Printing Like a Pro!* Programme, with both school and home versions including worksheets, is available for download and instructional use from the SunnyHill Health Centre for Child Development and Rehabilitation website - School-Age Therapy Practice Resources: http://www.childdevelopment.ca/School-Age_Therapy_Practice_Resources.aspx. We encourage you to access this resource and use it in your practice. Queries or feedback about the programme can be directed to the corresponding author.

While the *Printing Like a Pro!* programme has not been formally evaluated, it is based on current research evidence from multiple sources. The programme emerged from a partnership of a clinician scientist with experience in school-based occupational therapy practice and an occupational therapist with the initiative and interest to put evidence into practice. We hope that you will benefit from our experience, not only in using the resource we developed, but also from our example of knowledge translation. Together, clinician scientists and occupational therapists can bridge the gap between research and practice…one step (or letter!) at a time.

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