Effects of quantitative and qualitative treatment fidelity of an individualized computer-supported early reading intervention delivered by non-professional tutors

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ARTICLE INFO

ABSTRACT

This study investigated the effects of treatment fidelity, both quantitative (training time and lesson/program completion) and qualitative (level matching procedures, tutor support, and children's task orientation) on the outcome of an individualized computer-supported reading intervention provided by non-professional tutors (i.e., parents and volunteers). Thirty two children at risk of reading failure (14 Dutch schools) and their tutor participated in Kindergarten and Grade 1. Results indicated that 87% of the tutors were able to provide sufficient to high levels of support, 70% used adequate level matching procedures, and average quantitative treatment fidelity was 67%. Nearly all children showed sufficient to very high task orientation during the lessons. Stepwise regression analyses showed that quantitative treatment fidelity and child task orientation predicted reading outcomes in Kindergarten, after the summer break, and in Grade 1. Quantitative treatment fidelity was the strongest predictor at the first two measurements, and child task orientation in Grade 1.

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Children with reading problems experience great difficulty in education because they are limited in the use of written information. About a quarter of the students read below basic levels when they leave primary school (National Center for Education Statistics, 2011). It has been suggested that efforts should be made to prevent delays in reading by providing targeted support as early as possible, i.e. when the children are in the initial stages of learning how to read (National Reading Panel, 2000). The present study addresses the question whether that can be accomplished in a treatment-integrative and cost-effective way.

Early interventions are most effective when instruction focuses on the explicit and systematic training of phonological awareness and letter knowledge, followed by practice of the basic reading skills (Ehri et al., 2001). Moreover, instruction has to be adapted to the individual needs of children at risk of reading failure, the instructional period should be long and the practice is intensive (McDonald Connor et al., 2013). It is evident that, to fulfill these needs, computer-assisted programs are an effective tool (Blok, Oostdam, Otter, & Overmaat, 2002), more effective than individualized remedial teaching (Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2011), and cost-effective (e.g. Lynch, Fawcett, & Nicolson, 2000). At risk children also need social–emotional feedback and reinforcement. A human tutor is better suited to provide this support than a computer program (Azevedo,

Moos, Greene, Winters, & Cromley, 2008). To cope with the problem that inclusion of professional teachers consumes a considerable amount of resources, non-professional tutors such as parents or volunteers offer an alternative (e.g. Al Otaiba, Schatschneider, & Silverman, 2005; Vadasy, Sanders, & Peyton, 2005), in particular when combined with a computer program (Regtvoort, Zijlstra, & van der Leij, 2013). On the other hand, it has been suggested that treatment fidelity, the degree to which treatments are implemented as intended, is a particular concern when non-professionals serve as tutors, because they lack schooling and experience (Elbaum, Vaughn, Hughes, & Moody, 2000).

1. Treatment fidelity in reading intervention research

There are three ways to examine treatment fidelity (TF): (1) *describing* how TF is checked and/or promoted, (2) *measuring* TF, i.e. reporting the actual level of TF by means of numerical data to make statements about how well interventions were implemented, and/or (3) *investigating* the contribution of TF to intervention outcomes (Gresham, MacMillan, Beebe-Frankenberger, & Bocian, 2000). Although the importance of investigating TF is widely accepted, only about 20% of studies focusing on learning disabilities included TF of some sort (Gresham, 2009). Most recently published studies *described* or *measured* TF, but only five actually *investigated* it. For example, Al Otaiba et al. (2005) showed that children made significantly greater improvements when they practiced four times instead of two times per week with their community tutor. van Otterloo, van der Leij, and Veldkamp (2006) who used

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parents as tutors found that quantity was significantly related to the outcomes in Kindergarten. Tutor–child interaction quality added only to the prediction when children's pre-test scores were not included as control variable. Wolgemuth et al. (2011) found that instruction quality of the teacher using a computerized program was significantly related to phonological awareness in Kindergarten (two other examples can be found in Hatcher, Hulme, & Snowling, 2004, and Vadasy et al., 2005).

2. Measurement of treatment fidelity

In recent studies, quantitative treatment fidelity was measured by means of exposure/training time, including number of weeks (e.g. Vadasy et al., 2005), or by adherence/program completion (e.g., van Otterloo et al., 2006). With regard to qualitative treatment fidelity, three measures are important: level matching/differentiation, tutor instruction/support quality, and child task orientation. Matching the difficulty of what is taught to the mastery level of the learner contributes to the intervention outcome (Hatcher et al., 2004). Instruction/support quality during the lessons indicates TF across interventions (Schulte, Easton, & Parker, 2009). It is also evident that children who show higher levels of task-oriented behavior (i.e., put effort in their work and show persistence) learn more (Pintrich & Schunk, 2002).

3. The present study

A necessary condition for a study investigating treatment fidelity is an intervention program that has proven its efficacy. In a previous study (Regtvoort et al., 2013), we showed that children at-risk of reading failure who had finished a computer-assisted program delivered by non-professional tutors in Grade 1 and 2 outperformed untrained controls on all reading measures and maintained their benefit one year after finishing the program. It was concluded that this program (Bouw!, see Method) served as a (cost-)effective supplement to the classroom practice for beginning at-risk readers. However, it was also evident that efficacy depended on finishing the program. We decided to investigate in more detail, which aspects of treatment fidelity contributed to the outcome of the intervention, by providing an in-depth study of the experimental group.

Using the same program, non-professional tutors (parents and volunteers) delivered one-to-one reading instruction. It was investigated to what extent different aspects of treatment fidelity in Kindergarten and Grade 1 contributed to children's reading outcomes at three time points of the intervention: at the end of Kindergarten, after the summer break in Grade 1, and at the end of Grade 1. In addition to quantitative aspects (frequency and completion of the program), the focus was on three qualitative indicators (level matching procedures, tutor support and children's task orientation).

4. Method

4.1. Design

Table 1 shows occasions of test administration and the two phases of intervention. Children were individually tested by trained graduate students at school. The intervention in Kindergarten was carried out at home by the parents. There was no necessity to tune these activities with what was done at school because initial reading skills (i.e., letters, word segmentation and blending) are not formally taught in Dutch Kindergarten. The period was relatively short – 18 weeks (starting Mid-February) of the last Kindergarten year – to prevent overload in the home situation. A month after the summer break (six weeks starting in July) the intervention was continued in October of Grade 1, covering most of the school year (28 weeks). In Grade 1 it was carried out at school by non-professionals as supplementary practice to the reading instruction in the classroom.

4.2. Participants

After pre-selection by their teachers ($N = 363$), 142 children qualified as at-risk on the basis of test performance on phonological awareness at or below the 37th percentile and/or letter knowledge at least one standard deviation (SD) below the mean of the normative sample. The children were randomly assigned to the control ($N = 72$) or intervention condition ($N = 70$) within each school and classroom.

We selected 38 intervention children to participate in the in-depth study of treatment fidelity (TF). Three parents did not give permission for participation and three parents did not respond. On average, the participating 32 children (5.7 years old at selection) could read only three letters (Table 2). Their phonological awareness was slightly above the 20th percentile and around 85% scored low on both selection measures. Non-verbal IQ and receptive vocabulary represented average ability. Children's ethnic background was: 50% Dutch, 20% Surinamese/Dutch, 15% African, 12% Turkish/Moroccan, and 3% other. Around a quarter of the children had a second language background, but only a few parents spoke another language than Dutch as the first language.

In Kindergarten, 26 children practiced with one of their parents at home (4 fathers). The other six practiced with a volunteering adult at school because neither of the parents had time to practice. Of the Kindergarten tutors 47% finished a college or university degree, about 35% lower vocal education, and 18% high school; very few only finished primary school.

In Grade 1 two children stopped with the intervention because of good reading achievement. In Grade 1, 75% of the children had the same tutor all year. The remaining 25% worked occasionally with a second tutor (a few times per month). We included only the main tutors. All but two of the Grade 1 tutors were Dutch. These two were

Table 1
Occasions of test administration and periods of intervention.

	Kindergarten			Grade 1		
	Pre-test/selection	Intervention	Post-test 1	Post-test 2	Intervention	Post-test
	December	February–June K	June	October	November–June	June
Selection variables						
Productive letter knowledge	X					
Receptive letter knowledge	X					
Phonological awareness	X					
Outcome variables						
Reading subskills			X	X		
Reading fluency						X
Independent variables						
Quantitative treatment fidelity		X			X	
Qualitative treatment fidelity		X			X	