
Effectiveness of a Handwriting Intervention With At-Risk Kindergarteners

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MeSH TERMS

- handwriting
- education, special
- occupational therapy
- reading
- treatment outcome
- writing

OBJECTIVE. We examined the effectiveness of an occupational therapist–led handwriting intervention for special education and at-risk kindergarteners.

METHOD. We incorporated a two-group, pretest–posttest design. Both groups consisted of kindergarteners receiving individualized education program (IEP) or Response to Intervention (RtI) support. An occupational therapist provided biweekly group handwriting instruction using the Size Matters Handwriting Program to students in the intervention group ($n = 23$). The control group ($n = 12$) received the standard handwriting instruction.

RESULTS. Students in the intervention group demonstrated significantly greater gains in handwriting legibility than students in the control group. Students in the intervention group also demonstrated significantly greater gains in the prereading skills of uppercase letter recognition, lowercase letter recognition, and letter sound recognition.

CONCLUSION. This study provides preliminary support for an occupational therapist–led handwriting intervention to improve writing legibility and letter recognition in kindergarteners receiving RtI and IEP supports.

Zylstra, S. E., & Pfeiffer, B. (2016). Effectiveness of a handwriting intervention with at-risk kindergarteners. *American Journal of Occupational Therapy, 70*, 7003220020. <http://dx.doi.org/10.5014/ajot.2016.018820>

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In spite of the increased use of computers and tablets by children of younger and younger ages, handwriting remains an important skill for school success and continues to be a critical skill for elementary school students to acquire (Feder & Majnemer, 2007; McCarney, Peters, Jackson, Thomas, & Kirby, 2013; Vander Hart, Fitzpatrick, & Cortesa, 2010). Research has suggested that kindergarteners spend 36%–66% of their day participating in fine motor activities, with 42% of that time spent completing paper-and-pencil tasks (Marr, Cermak, Cohn, & Henderson, 2003). Beginning writers still do most of their composing by hand (Graham, Harris, & Fink, 2000), and difficulties with handwriting can have far-reaching effects on a child’s self-esteem and academic success (Feder & Majnemer, 2007).

It is well documented that handwriting instruction leads to handwriting automaticity (Berninger et al., 2006) and that automaticity leads to improvements in the output and content of written work (Graham et al., 2000). Graham et al. (2000) noted that first-grade students in a handwriting intervention group made notable gains in scores on both handwriting legibility and writing fluency. They concluded that the mastery of handwriting skills appears to facilitate the initial process of learning to write and that explicit handwriting instruction is an important element in preventing writing difficulties in the primary grades (Graham et al., 2000).

In addition, research has suggested that handwriting instruction can improve letter recognition and word reading skills (Berninger et al., 2006). Letter recognition skills have in turn predicted future reading abilities (Oslund et al.,

2015). Moreover, the physical act of handwriting is now known to recruit brain regions associated with successful reading. This finding recently led researchers to conclude that “handwriting may facilitate reading acquisition in young children” (James & Engelhardt, 2012, p. 32). Multiple studies have shown that kindergarteners’ letter identification skills are a consistent predictor of longitudinal reading outcomes (Bishop, 2003; Oslund et al., 2015; Simmons et al., 2014). Bishop (2003) noted that letter identification has historically been identified as the strongest single readiness skill in the prediction of early reading success, and Oslund et al. (2015) recently confirmed that sound and letter identification are early predictors of first- and second-grade reading outcomes. James and Engelhardt (2012) wrote, “In short, the ability to recognize individual letters of the alphabet is a crucial skill for reading” (p. 32). Certainly, the implementation of a handwriting intervention that results in considerable gains in letter naming and letter sound recall skills would be of high interest to teachers and administrators.

Successful Handwriting Interventions

Many studies have demonstrated that handwriting interventions are successful at improving handwriting skills in children (e.g., Berninger et al., 2006; Case-Smith, Holland, & Bishop, 2011; Case-Smith, Holland, Lane, & White, 2012; Case-Smith, Weaver, & Holland, 2014; Graham et al., 2000; Howe, Roston, Sheu, & Hinojosa, 2013; Jongmans, Linthorst-Bakker, Westenberg, & Smits-Engelsman, 2003; Marr & Dimeo, 2006; Pfeiffer, Murray, Rai, & Brusilovskiy, 2015). However, few researchers have examined handwriting outcomes with children in special education services (Fuentes, Mostofsky, & Bastian, 2009; Jongmans et al., 2003; Marr & Dimeo, 2006)—the population most often served by school-based occupational therapists. Additionally, research regarding the combination of elements necessary to make an intervention successful is still emerging.

Hoy, Egan, and Feder (2011) completed a systematic review of the literature related to handwriting outcomes and concluded that it is essential to include a handwriting practice component in any handwriting intervention. Multiple authors have supported this conclusion (Berninger et al., 2006; Mackay, McCluskey, & Mayes, 2010; Vander Hart et al., 2010). Hoy et al. also found that “activities that target writing related performance components, such as in-hand manipulation or kinesthetic awareness, without providing opportunity for handwriting practice, do *not* appear to be effective in improving written expression” (p. 22). This finding is important to consider, because

some occupational therapists continue to emphasize remediation of component skills at the expense of providing functional handwriting interventions. Mackay et al. (2010) supported a growing body of literature in which a motor learning model for handwriting interventions is recommended. Another promising strategy for teaching handwriting is the use of a cognitive approach (Zwicker & Hadwin, 2009).

Providing Handwriting Interventions in Response to Intervention and Special Education Settings

Increasingly, referrals to special education services are being postponed until efforts have been made to improve student skills through the use of a Response to Intervention (RtI) model, thus reducing or even eliminating the need for special education services for some children (American Occupational Therapy Association [AOTA], 2011). The RtI provision, introduced in the 2004 reauthorization of the Individuals With Disabilities Education Act (Pub. L. 108–446), is a general education initiative designed to meet the needs of struggling students in the general education setting (AOTA, 2011; Ohl et al., 2013). *RtI* is defined as the practice of providing quality instruction matched to student needs (Cahill, 2007), and it consists of high-quality, research-based classroom instruction combined with continuous progress monitoring. Decisions regarding future services are based on a student’s response to the intervention (AOTA, 2011; Bradley, Danielson, & Doolittle, 2005). RtI follows a three-tiered intervention approach. Tier 1 typically includes schoolwide interventions (Ohl et al., 2013). Tier 2 is often described as interventions provided in smaller group settings outside of the general education classroom, whereas Tier 3 services are often provided on a one-to-one basis (Bradley et al., 2005).

In school-based occupational therapy practice, therapists often assess children with writing difficulties. Overvelde and Hulstijn (2011) stressed that it is important not to provide specialized therapeutic intervention to children who will improve with exposure, extra practice, or RtI services. Hoy et al. (2011) agreed, writing that it may be better to advocate for intensive practice for children having difficulty acquiring handwriting before referring them to special education for therapeutic intervention. RtI is an ideal way to address the handwriting needs of such children, and occupational therapists are perfectly positioned to provide beneficial RtI services to children in general education settings (Cahill, 2007; Ohl et al., 2013).

Research Aims and Questions

Studies in which researchers examine the outcomes of handwriting instruction provided to the at-risk population are greatly needed to determine whether outcomes are similar to those seen in the typically developing population. Studies in which researchers examine outcomes in non-traditional classroom settings, in addition to those settings manipulated for experimental research, are also needed. Such studies may not be as “clean” as those in classic experimental research; however, it is imperative to examine outcomes in the settings that are occurring in today’s schools. At-risk children are increasingly being provided intensive interventions under an RtI model, and children receiving special education services are increasingly being integrated into less restrictive settings, thus creating classroom environments with a wide variety of student needs. Therefore, the purpose of this study was to examine the outcomes of a handwriting intervention, the Size Matters Handwriting Program (SMHP; Moskowitz, 2009), provided to kindergarten children currently receiving individualized education program (IEP) or RtI support. In this study, we attempted to answer two research questions:

1. Will at-risk kindergarteners (those children receiving IEP or RtI support) participating in a 16-wk, occupational therapy–led handwriting SMHP intervention group demonstrate considerably greater improvements in handwriting legibility than children who do not receive the intervention?
2. Will at-risk kindergarteners participating in an SMHP handwriting intervention make considerably greater gains in the prereading skills of letter name recognition and letter sound recall than students who do not receive the intervention?

Method

Research Design

In this study, we used a two-group, pretest–posttest design. Outcome measures of handwriting, letter name recognition, and letter sound recall were administered at pretest and posttest. We obtained institutional review board approval, with waiver of consent, prior to implementation. In addition, school administrators provided written consent for classroom participation. Administrators at the intervention schools also provided consent for the adoption of the SMHP as the standard intervention in support classrooms.

Participants

A convenience sample of all children participating in three kindergarten support classrooms ($n = 35$) in rural

Washington State was included in this study. All participants were receiving educational support in the form of IEP or RtI Tier 2 interventions and were participating in a support classroom in which those services were being delivered. The intervention group consisted of 23 kindergarten students comprising all students in two kindergarten support classrooms, one in each of two neighboring schools. The control group consisted of 12 kindergarteners comprising all students in a kindergarten support classroom at a third school. Because only three classrooms met the criteria for participation, two classrooms were chosen for the intervention group, and one classroom was chosen as the control group, thus resulting in unequal group numbers. Because of the heavy focus on meeting the Common Core standards and the desire to limit student disruptions, administrators were unwilling to have students with handwriting needs pulled for an additional handwriting intervention. They were, however, willing to have the therapist enter the support settings and provide the intervention to all students participating in those classrooms. This delivery model supports the “push in” versus “pull out” service trend, but it created some difficulty from a research design perspective.

All children (intervention and control groups) attended their homeroom or general education classroom for at least half of the school day. They transferred to their support classroom daily for reading and writing interventions as well as additional interventions, including math, social–emotional, or adaptive assistance, as needed. In addition to the occupational therapist–led handwriting intervention, students in the intervention group continued to receive their school-based handwriting instruction while in their primary setting. Students in the control group received their school-based handwriting instruction, but they did not receive the additional occupational therapist–led handwriting instruction. Students in both groups who received occupational therapy as part of their IEP program continued to receive those services as outlined by their IEPs.

Intervention

The SMHP (Moskowitz, 2009) was developed by an occupational therapist on the basis of current research regarding the necessary components for handwriting acquisition. The SMHP incorporates principles grounded in Motor Learning Theory, Cognitive Theory, and Motivation Theory (Moskowitz, 2009). The SMHP incorporates Motor Learning Theory by embedding practice and repetition into program materials and throughout the day. Principles of Motivation Theory are incorporated through colorful, fun, and engaging activities. Workbooks

are designed to be used with children in kindergarten through second grade, but SMHP principles can be applied throughout grade school. Cognitive principles are incorporated into the direct instruction of explicit letter formation techniques with consistent, meaningful terminology. Children learn the importance of letter size by learning “Size 1” letters (capital and tall letters), “Size 2” letters (small letters), and “Size 3” letters (those that dive below the baseline) at different stages (Moskowitz, 2009; also see <http://www.realotsolutions.com>). Recent research that examined the use of the SMHP provided support for this program as an intervention in the general education population (Pfeiffer et al., 2015).

The intervention group received a total of 30 sessions of the SMHP, completed twice weekly over a 16-wk period. This formula was based on recent research by Hoy et al. (2011). In their review of the literature related to handwriting outcomes, Hoy et al. noted a positive relationship between the number of sessions and intervention effectiveness. They observed that “all studies with fewer than two practice sessions per week and fewer than 20 practice sessions in total (homework included) demonstrated ineffective results” (p. 19). On the basis of this research and the time required to cover instruction of all upper- and lowercase letters, a target of 30 sessions was set. Sessions lasted 30 min and were led by an occupational therapist with 25 years of experience (12 yr of school-based experience) who was trained in the SMHP (the lead investigator and first author). Training was obtained by viewing online video tutorials and by studying the fidelity manual.

The lead investigator was not affiliated with the SMHP in any way, and therefore no conflicts of interest were noted. All interventions were provided within the existing support classrooms. Three additional adult helpers assisted with each session, for a ratio of 1 adult to every 3 children. Adult helpers consisted of the support classroom teacher, a certified occupational therapy assistant, and an educational assistant trained by the lead investigator. Each child had his or her own SMHP workbook. Adapted writing utensils were provided on an as-needed basis, including pencils with grips, triangular pencils, and large-diameter pencils.

Intervention Fidelity

A fidelity manual was written by the SMHP author for use in a previous study (Pfeiffer et al., 2015). Guidelines in the manual were adhered to, and letters were introduced in the sequence suggested. All sessions were led by the first author and were conducted in a consistent manner on the basis of recommended procedures in the manual. Uppercase letters (Size 1) were introduced first, with lowercase letters (Size 2 and Size 3) introduced later.

Typically, two letters were completed at each session, with several sessions dedicated to the review of previously taught letters. Support room teachers were present for all sessions and were encouraged to incorporate SMHP principles throughout the day.

Outcome Measures

Test of Handwriting Skills–Revised. The Test of Handwriting Skills–Revised (THS–R; Milone, 2007) is a standardized assessment of handwriting that can be administered to students ages 6–18 yr. Ten subtests include writing letters and numbers from memory; writing letters, numbers, and words from dictation; copying letters; copying words; copying short sentences; and writing short words from dictation (Milone, 2007). The corrected test–retest correlation is documented as .82 for the total test score and .49–.82 for individual subtests (Milone, 2007). Internal consistency coefficients are reported as ranging from .61 to .92, whereas most subtest internal consistency reliability coefficients exceed .80 (Milone, 2007). Interrater reliability ranges from .59 to 1.00, with interrater reliability rating averages ranging from .72 to 1.00 (Milone, 2007).

Authors have suggested that the appropriate time to initiate formal handwriting instruction is in the second half of the kindergarten year (Beery & Beery, 2010; Daly, Kelley, & Krauss, 2003). Because no commercially available handwriting assessments normed for students younger than age 6 yr currently exist, formal assessment of kindergarteners’ handwriting is difficult. For the purposes of this study, we used the THS–R 6-yr norms for students younger than age 6.

North Dakota Title I Kindergarten Reading Standards Assessment (Letter Identification Subtest). The North Dakota Title I Kindergarten Reading Standards Assessment is a screening tool developed by the North Dakota Department of Public Instruction (1996). The North Dakota Title I Kindergarten Reading Standards Assessment is aligned with North Dakota state standards and consists of several subtests, including letter identification, word recognition, concepts about print, and sentence dictation. The assessment was designed as a tool for teachers and educators in selecting Title I students or assessing student achievement. As of yet, no available reliability or validity data for this assessment exist.

For the purposes of this study, only the letter identification subtests of Letter Name and Letter Sound were used. The assessment includes a standard form with uppercase letters printed at the top and lowercase letters printed at the bottom. Letters are presented in random order rather than alphabetically. The lead investigator pointed to each letter and asked for either the name or the

sound of the letter. Skills were assessed in the following order: uppercase letter names, lowercase letter names, and uppercase letter sounds. Lowercase letter sounds were not assessed because, at the time of pretesting, many students in this sample could recall few letter sounds. Therefore, to avoid frustration, we assessed only uppercase letter sounds.

Results

Data obtained from test scores were analyzed with IBM SPSS Statistics (Version 22; IBM Corporation, Armonk, NY). A statistical adviser consulted with the analysis.

The intervention group ($n = 23$) was made up of 14 boys (61%) and 9 girls (39%). Ages at pretest ranged from 63 to 77 mo (mean age = 68.7 mo, standard deviation [SD] = 3.98). The control group ($n = 12$) was split equally with 6 boys (50%) and 6 girls (50%). Ages at pretest ranged from 64 to 81 mo (mean age = 71.8 mo, $SD = 5.19$). See Table 1 for further demographic information.

A χ^2 analysis was completed on demographic data to determine any between-groups differences that may affect interpretation of the data. Results of the χ^2 analysis revealed that the intervention and control groups were statistically similar in all demographic areas but one. No notable between-groups differences were found in age, gender, handedness, free lunch status, or number of students receiving occupational therapy. However, considerable group differences were noted in the area of IEP status. A considerably higher percentage of students in the control group (83%) than in the intervention group (39%) were on current IEPs. This finding is further addressed in the Discussion section.

Table 1. Participants' Demographic Characteristics

Variable	Intervention Group ($n = 23$), n (%)	Control Group ($n = 12$), n (%)
Gender		
Male	14 (61)	6 (50)
Female	9 (39)	6 (50)
Median age, mo	68.7	71.8
Hand dominance		
Right	21 (91)	10 (83)
Left	2 (9)	2 (17)
Students qualifying for free lunch	23 (100)	12 (100)
Students on an IEP	9 (39) ^a	10 (83) ^a
Students receiving occupational therapy services	8 (35)	3 (25)

Note. IEP = individualized education program.

^aA χ^2 analysis revealed significance at .01 for differences between groups on this characteristic.

Handwriting Legibility

Independent t tests were run to determine whether pretest total (full scale) scores on the THS-R represented similar levels of handwriting legibility between the control and intervention groups before intervention. Results demonstrated that at pretesting there were no significant differences between the intervention and control groups on handwriting legibility, $t(33) = 1.91, p > .05$. A p score of $>.05$ indicates that results are not significant—in this case suggesting that there was no considerable difference between groups before the intervention.

Because groups were similar at pretesting, the assumption of homogeneity was met. Additional independent t tests were run to determine whether handwriting legibility gain scores for the intervention group were significantly greater than handwriting legibility gain scores for the control group. Results demonstrated that THS-R full scale gain scores for the intervention group were significantly greater than gain scores for the control group, $t(33) = 4.12, p = .000$. See Table 2 for gain scores.

Prereading Skills

Finally, independent t tests were run to compare gains in letter recognition and letter sound recall between the intervention and control groups. An initial independent t test was run to ensure that the intervention and control groups were homogeneous before further analysis. Results indicated that the intervention and control groups presented with similar scores at pretesting in the areas of uppercase letter recognition, $t(33) = -1.52, p > .05$; lowercase letter recognition, $t(33) = -0.84, p > .05$; and letter sound recognition, $t(33) = -0.05, p > .05$.

An additional independent t test analysis was conducted to examine gain scores in letter recognition and letter sound recall. For uppercase letter recognition, gain scores were significantly greater for the intervention group, $t(33) = 2.34, p < .05$. A p score of $<.05$ indicates a significant difference between groups. See Table 2 for detailed results of the independent t test analysis. Similarly, significantly greater gains were noted for the intervention group compared with the control group when examining lowercase letter recognition gain scores, $t(33) = 2.27, p < .05$, and letter sound recall gain scores, $t(33) = 2.46, p < .05$. As stated previously, data were collected for letter sound recognition of uppercase letters only.

Discussion

The kindergarteners in this study, who participated in the SMHP intervention in addition to their standard

Table 2. Comparison of Gain Scores for Intervention and Control Groups

Variable	Group	<i>n</i>	<i>M</i>	<i>SD</i>	Gain Score Differences	<i>t</i>	Significance (2-Tailed)
THS-R full scale	Intervention group	23	21.91	10.58	13.83	4.12	.000
	Control group	12	8.08	6.50			
Uppercase letter recognition	Intervention group	23	12.48	5.87	5.06	2.34	.026
	Control group	12	7.42	6.50			
Lowercase letter recognition	Intervention group	23	12.83	5.20	4.58	2.27	.030
	Control group	12	8.25	6.50			
Uppercase letter sound recognition	Intervention group	23	14.65	5.05	4.57	2.46	.019
	Control group	12	10.08	5.52			

Note. Gain scores are the mean gain in scores from pretesting to posttesting. *M* = mean; *SD* = standard deviation; THS-R = Test of Handwriting Skills-Revised.

handwriting instruction, demonstrated considerably greater gains in handwriting legibility than students who participated in their school's standard handwriting instruction only. These results provide initial support for the use of the SMHP as a successful intervention for improving handwriting skills in kindergarten children who are receiving IEP or RtI support.

These results support the findings of previous researchers who demonstrated that handwriting interventions improve legibility (e.g., Berninger et al., 2006; Case-Smith et al., 2011, 2012, 2014; Graham et al., 2000; Howe et al., 2013; Jongmans et al., 2003; Marr & Dimeo, 2006; Pfeiffer et al., 2015). What sets the current study apart from previous research is that we examined the effectiveness of the SMHP when used with an at-risk population. In addition, in this study the intervention group made considerably greater gains in the areas of letter name recognition and letter sound recall, skills that are known to contribute to reading success. These findings suggest that a handwriting intervention in which the SMHP is used has the potential not only to improve handwriting legibility but also to contribute to early reading outcomes when used in addition to the standard handwriting instruction. These results support emerging research connecting the physical act of handwriting to early reading development (James & Engelhardt, 2012).

The administration age range of 6–18 yr presents some problems for gathering data at the middle of the kindergarten year, because many kindergarteners in the middle of the year are not yet age 6 yr. Because researchers have suggested teaching handwriting during the kindergarten year (Beery & Beery, 2010; Daly et al., 2003), and because many schools begin handwriting instruction during the kindergarten year, it is essential to use a tool that will measure this skill accurately during the kindergarten year. Because no handwriting assessments currently exist on the market that are normed for students younger than age 6 yr, formal assessment of kindergarteners' handwriting is difficult. For the purposes of this study, we used THS-R 6-yr norms for all students

younger than age 6 yr. In the current study, gain scores were determined by comparing each kindergartener's pretest scores with his or her own posttest scores. This strategy reduced some concern regarding interpretation of scores.

Limitations

As is often the case with clinical research, several limitations of this study should be considered. First, although the intervention group received the SMHP, both the intervention and the control groups continued to receive their school's standard handwriting instruction. Therefore, the additional gains made by the intervention group may be because additional handwriting intervention was received, rather than a result of the type of intervention (SMHP). Second, both groups were made up of classrooms with different teachers, in different schools. Schoolwide philosophies regarding handwriting intervention and individual teacher philosophies regarding the importance of handwriting instruction differ. These differences likely affected the level of exposure to handwriting instruction provided in each setting.

Additionally, the control group did not have the high adult-to-student ratio that was available to the intervention group (3:1). Moreover, children in both groups who were receiving occupational therapy services may have had goals specific to handwriting and may, therefore, have received additional handwriting assistance. It is not known what percentage of students receiving occupational therapy services had goals and services related to handwriting. These factors may have affected the results. Finally, external validity checks might have strengthened the study but were not feasible because of student confidentiality.

An important demographic difference between the intervention and control groups should be addressed in future research. In the intervention group, 39% of students were receiving either IEP or both IEP and RtI support, whereas the remaining 61% were receiving support in the form of RtI only. In the control group, a much higher percentage of students (83%) was receiving IEP support; a much smaller percentage (17%) was

receiving RtI support services only. Students can receive both IEP and RtI support. For example, some students receiving IEPs in reading and written language under the special education model may also have been receiving RtI in the form of supportive small group instruction in math, or another area, under the umbrella of general education. Because of confidentiality, it is not known what percentage of students in this study receiving IEPs in one or more areas might also have received RtI in another area. Therefore, one should consider how receiving IEP versus RtI support might affect a child's response to an intervention. It may be that children receiving special education services require more intensive, or more direct, intervention to achieve the same level of gains as children receiving RtI.

Finally, the sample size of 35 students (23 in the intervention group and 12 in the control group) is small, and thus generalizations should be made with caution. In addition, because the student sample was one of convenience, results should be generalized with care. Because the lead author was also the occupational therapist leading the interventions, she was not blind to the participants' pretesting status during intervention.

Future Research

This study constitutes preliminary research, and replication of these findings is highly encouraged. In future studies, it will be important to include a larger and more homogeneous sample. In analyzing future handwriting outcomes with the THS-R, it will be important to examine both subtest scores and total scores to determine to what extent changes occurred in motor skills (copying subtests) versus cognitive skills (memory subtests). Ideally, in future research, students will receive the SMHP intervention *instead of* the standard handwriting intervention rather than *in addition* to the standard intervention.

Implications for Occupational Therapy Practice

The SMHP is a unique handwriting program developed on the basis of the most current research regarding outcomes. The results of this study have the following implications for occupational therapy practice:

- Kindergarten students with IEPs and in the at-risk population can make substantial progress when given direct instruction in handwriting.
- This study demonstrates support for the use of the SMHP when used in addition to the standard handwriting intervention for improving handwriting legibility provided in a special education and RtI setting.

- This study lends support to recent evidence that handwriting interventions can improve early reading skills. Occupational therapists need to approach administrators with this evidence in support of continuing direct handwriting instruction in schools. ▲

Acknowledgments

We thank the students, teachers, and assistants who participated in this study. The first author also thanks the faculty and students at Temple University's Department of Occupational Therapy for their guidance and support. This study is registered under ID No. NCT02620098 at ClinicalTrials.gov.

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