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## **When children face fear: treatment, child, and family factors in cognitive behavioral therapy for childhood anxiety**

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# Chapter 4

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## Evaluating the impact of an app-based homework program following One-Session Treatment for childhood phobias: A randomized controlled trial

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Based on:

Hagen, A., Ollendick, T.H., Zimmermann, R., de Jong, T., van Steensel, F. J. A., Krause, K., Rahemania, J., de Bruin, E. I., Velthuisen, S. L. M., van Rijswijk, L., Meckling, H. I., Bexkens, A., de Gier, E., Baartmans, J. M. D., Moback, L., Nauta, M. H., Bögels, S. M., Rapee, R. M., Schneider, S. & Klein, A. M. (in publication). Evaluating the impact of an app-based homework program following One-Session Treatment for childhood phobias: A randomized controlled trial. *Journal of the American Academy of Child and Adolescent Psychiatry*.

## ABSTRACT

Specific phobias are among the most common, earliest-onset mental disorders in youth. Although One-Session Treatment (OST) is a well-established intervention, 35-40% of children do not reach full remission. This study examined whether supplementing OST with a child-focused, app-supported homework program enhances outcomes. A total of 172 children (ages 7–14;  $M = 10.65$ ,  $SD = 2.09$ ; 59% girls) meeting criteria for any specific phobia participated in a parallel-group randomized superiority trial and received standard OST before randomization to therapist-provided homework (OST-only) or an app-supported program (OST + app). Assessments occurred before and after a 3-week baseline, post-OST, post-practice, and at 6-month follow-up. Primary outcomes were diagnostic status and clinician-rated severity; secondary outcomes included behavioral avoidance, self-reported fear and avoidance, and functional impairment. Mixed-effects linear models were used. Both groups showed significant improvements on all outcomes, with medium-to-large effect sizes and gains maintained through post-practice and follow-up. Remission rates were 25.2% post-OST, 46.0% post-practice, and 69.6% at follow-up. Children in both conditions practiced frequently. The app-supported homework program did not enhance outcomes or at-home practice. Families in the OST + app condition reported higher treatment satisfaction. Children with blood-injection-injury phobias showed lower remission rates than those with other phobias. Findings underscore the effectiveness of OST across diverse clinical settings. The app-supported homework program did not enhance outcomes, while families reported higher treatment satisfaction, suggesting potential value warranting investigation. Future research should clarify whether specific child or symptom profiles may benefit from app-based support and strengthen OST implementation.

**Keywords:** Specific phobia, children, One-Session Treatment, app, homework program

Children with specific phobias often experience profound disruptions in daily life, avoiding routine activities, places, or situations due to overwhelming fear. These struggles frequently extend to social interactions and academic performance, hindering engagement with peers and learning (Essau et al., 2000; Stinson et al., 2007). Given these significant impairments, it is concerning that specific phobias—despite being among the most prevalent childhood mental health disorders—remain undertreated and are associated with an increased risk of later psychopathology (American Psychiatric Association, 2022; Lieb et al., 2016).

Cognitive-behavioral therapy (CBT), including One-Session Treatment (OST), has consistently demonstrated efficacy for childhood phobias (In-Albon & Schneider, 2007; de Jong et al., 2023; Ollendick & Davis, 2013; Seligman & Ollendick, 2011). OST is a brief, intensive intervention centered around a single three-hour exposure session (Öst, 1989; Öst & Ollendick, 2001), making it highly exposure-focused. While OST is highly efficacious, with most children improving significantly, approximately 35-40% do not reach full remission, highlighting the need for treatment enhancement (Ollendick et al., 2009; Öst & Ollendick, 2017).

Exposure is widely recognized as a key component of CBT for anxiety disorders, targeting catastrophic cognitions by allowing the child to encounter feared stimuli without the anticipated negative outcome (Craske et al., 2022; Waters & Craske, 2016; Whiteside et al., 2020). Because repeated practice is essential, homework is used to extend exposure beyond therapy sessions. In adults, homework adherence across various disorders shows small to medium effects on treatment outcomes (Kazantzis et al., 2016; Mausbach et al., 2010), but evidence in youth is limited, and studies have not found consistent additional benefits (Arendt et al., 2016; Hughes & Kendall, 2007; Lee et al., 2019).

Digital health innovations may enhance both the quality of and engagement with homework (Berry & Lai, 2014; Bunnell et al., 2021; Muroff & Robinson, 2022; Tang & Kreindler, 2017). Apps can support individualized tasks, track progress, provide real-time feedback, and incorporate motivational features such as gamification, rewards, and reminders, facilitating skill practice across contexts (e.g., Hill et al., 2018; Pramana et al., 2018). These features may also reduce common barriers to homework compliance, including forgetfulness and negative associations with homework (e.g., Bunell et al., 2021). Although several apps show promise in usability, satisfaction, and short-term outcomes, rigorous evaluation is needed to determine their long-term effectiveness and unique contribution to treatment gains. Notably, many apps lack empirical validation and include few evidence-based components (for a review, see Chapter 2).

Therefore, we developed and evaluated the added value of a personalized, app-supported homework program designed to facilitate home-based exposure practice following OST. The program incorporates the *Kids Beat Anxiety* (KibA) app, which offers customizable exposure tasks and rewards to support exposure practice outside therapy (for details, see Chapters 2

and 3). We examined whether OST followed by this app-based homework program would lead to superior outcomes compared to standard OST. In addition, we aimed to replicate the established efficacy of standard OST for childhood specific phobias in the Netherlands and Germany. We hypothesized that OST followed by the app-based homework program would outperform standard OST, and that both active conditions would outperform a three-week waiting period.

## METHOD

### Participants

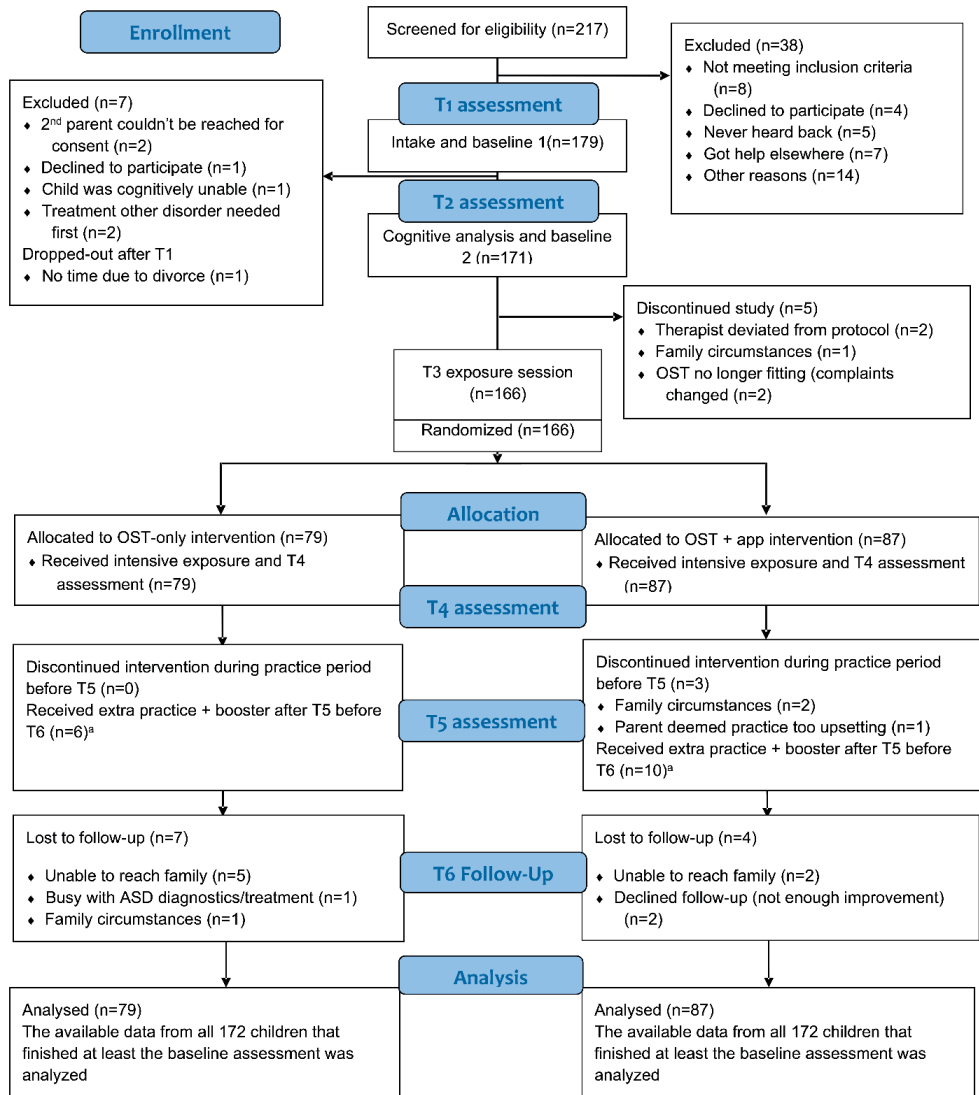
A total of 172 children and adolescents aged 7 to 14 years ( $M = 10.65$ ,  $SD = 2.09$ ; 102 females) referred for treatment for specific phobia were enrolled between February 2021 and May 2024. The study was conducted in six outpatient clinics (three university-affiliated, three community-based). Participants were recruited via flyers, online platforms, schools, family doctors, and routine referrals. Inclusion criteria were: (1) a current primary or secondary DSM-5 diagnosis of specific phobia, (2) at least one caregiver willing to participate, (3) active consent from both legal guardians and assent from the child if aged  $\geq 12$  years, and (4) fluency in German, Dutch, or English. Exclusion criteria were: (1) conditions requiring treatment before the specific phobia intervention (e.g., severe depressive symptoms, psychosis), (2) child welfare concerns, (3) difficulty understanding study procedures (e.g., significant intellectual disability), or (4) concurrent treatment for anxiety during the 9-week period between baseline and post-practice.

Participants were randomly assigned to OST-only ( $n = 79$ ) or OST supplemented with an app-based homework program (OST + app;  $n = 87$ ). Six participants dropped out before allocation (see the CONSORT flow diagram in Figure 1). Randomization (1:1), conducted via LOTUS—an online platform developed by the University of Amsterdam for longitudinal research—was stratified by treatment center, phobia type, and clinical severity. All phobia subtypes were eligible for participation. Sociodemographic and baseline characteristics by treatment group are presented in Table 1. There were no significant baseline differences between groups in gender, age, or phobia severity. Assessors were masked to treatment conditions and pre-treatment phobia severity.

The study was approved by the Medical Ethics Review Committee of the Academic Medical Center, Amsterdam, the Netherlands (NL72697.018.20) and the Ethical Committee of Ruhr University, Bochum, Germany (663). The trial was preregistered with the Overview of Medical Research in the Netherlands (OMON; ID: NL-OMON55077) on March 24, 2020, and the study protocol was published in *Contemporary Clinical Trials Communications* (Klein et al., 2024).

**Figure 1**

CONSORT 2010 Flow Diagram



<sup>a</sup> If children still fulfilled diagnostic criteria post-practice (T5) and the family wished to continue with treatment four more weeks of practice were scheduled, followed by a booster session if still needed.

**Table 1**

*Demographic and Descriptive Data for the Entire Sample and Between the Two Groups at Baseline*

|                                 | Total sample<br>(N = 172) |              | OST-only<br>(n = 79) |              | OST + app<br>(n = 87) |              | Test-statistic              | p    |
|---------------------------------|---------------------------|--------------|----------------------|--------------|-----------------------|--------------|-----------------------------|------|
|                                 | n (%)                     | M (SD)       | n (%)                | M (SD)       | n (%)                 | M (SD)       |                             |      |
| Child age in years              |                           |              |                      |              |                       |              |                             |      |
| Number of female participants   | 102 (59.3)                | 10.65 (2.09) | 44 (55.7)            | 10.46 (2.02) | 54 (62.1)             | 10.77 (2.18) | $t(164) = -0.96$            | .338 |
| Phobia type                     |                           |              |                      |              |                       |              |                             |      |
| Animal                          | 66 (38)                   |              | 31 (39)              |              | 35 (40)               |              |                             |      |
| BII                             | 69 (40)                   |              | 31 (39)              |              | 34 (39)               |              |                             |      |
| Natural environment             | 8 (5)                     |              | 4 (5)                |              | 4 (5)                 |              |                             |      |
| Situational                     | 8 (5)                     |              | 4 (5)                |              | 4 (5)                 |              |                             |      |
| Other                           | 21 (12)                   |              | 9 (11)               |              | 10 (11)               |              |                             |      |
| CSR for primary phobia          |                           | 5.84 (1.11)  |                      | 5.84 (1.05)  |                       | 5.81 (1.17)  | $t(161) = 0.17$             | .863 |
| More than one phobia            | 73 (42)                   |              | 34 (43)              |              | 36 (41)               |              | $\chi^2(1, N = 166) = 0.00$ | .953 |
| Comorbid other anxiety disorder | 42 (25)                   |              | 20 (26)              |              | 21 (24)               |              | $\chi^2(3, N = 163) = 2.38$ | .498 |
| Comorbid mood disorders         | 3 (4)                     |              | 2 (3)                |              | 1 (1)                 |              | $\chi^2(2, N = 163) = 1.13$ | .568 |
| Presence of ADHD, n (%)         | 28 (17)                   |              | 13 (17)              |              | 15 (17)               |              | $\chi^2(2, N = 163) = 0.91$ | .636 |
| Family type (two parent)        | 140 (84)                  |              | 64 (83)              |              | 72 (86)               |              | $\chi^2(1, N = 161) = 0.06$ | .813 |
| Primary carer education         |                           |              |                      |              |                       |              | $\chi^2(3, N = 157) = 5.59$ | .134 |
| University                      | 54 (33)                   |              | 30 (40)              |              | 23 (28)               |              |                             |      |
| Applied university              | 49 (30)                   |              | 19 (25)              |              | 30 (37)               |              |                             |      |
| Intermediate vocational         | 34 (21)                   |              | 17 (23)              |              | 13 (16)               |              |                             |      |
| Other                           | 25 (15)                   |              | 9 (12)               |              | 16 (20)               |              |                             |      |

*Note.* Six children dropped out before randomization. For some measures data for one or more children was missing (range of missing data 3–10). No formal or comprehensive screening was conducted for diagnoses outside mood and anxiety disorders. Comorbidity was not an exclusion criterion to maintain a representative clinical sample. On the intake questionnaire, parents of 11 children reported additional diagnoses beyond anxiety: 1 oppositional defiant disorder, 3 autism spectrum disorder, 1 Tourette's disorder, 5 ADHD, and 1 language disorder.

## MEASURES

### Primary Outcomes

The presence and severity of a specific phobia was assessed using semi-structured diagnostic interviews: the *Anxiety Disorders Interview Schedule for DSM-IV: Child and Parent Versions* (ADIS-IV-C/P; Silverman & Albano, 1996) at the Dutch sites and the *Diagnostic Interview for Mental Disorders in Children and Adolescents* (Kinder-DIPS; Margraf et al., 2017; Schneider et al., 2017) at the German site. Both interviews have demonstrated good reliability and validity (e.g., Neuschwander et al., 2013; Schneider et al., 2009; Silverman et al., 2001; Wood et al., 2002). Both interviews assess anxiety and related disorders according to DSM-5 criteria and yield a Clinician Severity Rating (CSR) on a 0–8 scale, with scores of 4 or higher indicating a clinical diagnosis. During all assessments, the full 0–8 range, including subclinical ratings (0–3), was retained for analysis. The ADIS-IV-C/P was slightly adapted to reflect DSM-5 criteria, as the ADIS-5-C/P was not yet available in Dutch. Parent and child interviews were conducted separately, and a composite CSR was based on the higher of the two scores (Cresswell et al., 2021; Silverman & Albano, 1996).

In total, 47 interviews—randomly selected from intake, pre-, post-, and follow-up assessments—were double-rated to establish interrater reliability. The intraclass correlation coefficient [ICC(2,1); two-way random effects, absolute agreement] for the Clinician Severity Rating (CSR) was .907. In 86% of cases, both raters agreed on the presence or absence of the primary phobia diagnosis.

### Secondary Outcomes

**Behavioral Avoidance.** In vivo behavioral avoidance was measured using *Behavioral Approach Tests* (BATs; adapted from Ollendick et al., 2009). BATs were specifically constructed and individualized to each child's fear. Each BAT consisted of 9–12 steps that increased in difficulty. Children were instructed to approach the feared situation or object but could stop whenever they chose not to continue. The percentage of completed steps was used for analysis. Previous research has demonstrated good test-retest reliability ( $r = .87$ ; Ollendick et al., 2009).

**Self-Reported Fear and Avoidance.** An adapted version of the *Anxiety and Avoidance Scale for Children* (AVAC; Lippert et al., 2021) was used to assess fear and avoidance of the phobic stimulus. Together with the therapist, parents and children listed up to five feared situations that were considered relevant treatment goals. The first three related to the primary fear, and two additional items could address non-primary fears for exploratory purposes (not used in this study). For each item, parents and children rated the child's fear (1 = no fear to 5 = very strong fear) and avoidance (1 = never avoids to 5 = always avoids). The AVAC has demonstrated reliability, validity, and sensitivity to treatment change (Lippert et al., 2021).

**Functional Impairment.** Functional impairment in school, social, and family life was assessed with the child version (Schneider, 2000) of the *Sheehan Disability Scale* (SDS; Sheehan, 1983). Parents and children rated the extent to which anxiety interfered with the child's functioning in each domain, (from 0 = not at all to 3 = very much). This child-adapted version has shown good reliability (Schneider et al., 2013).<sup>1</sup>

## INTERVENTIONS

The study utilized OST for childhood specific phobia (Öst & Ollendick, 2001). OST is an individualized intensive cognitive-behavioral therapy centered around a single 3-hour exposure session. The treatment incorporates social learning principles (instruction, modeling, reinforcement) and psychoeducation. The exposure session is preceded by a 1-hour cognitive behavioral analysis to identify catastrophic cognitions underlying the phobia and examine fear and avoidance behaviors. These cognitions guide the exposure session, which consists of behavioral experiments designed to test and disconfirm maladaptive beliefs. Participants in both conditions received the same 3-hour OST intervention. One week later, participants and parents attended a session for assessment and homework instructions. After four weeks of home practice, all participants returned for a treatment evaluation (up to one hour) and discussion of next steps.

Participants in the OST-only condition received standard OST homework instructions, including verbal guidance and a take-home sheet outlining the importance of practice, strategies for managing setbacks, and encouragement to practice regularly. The therapist discussed one or two examples of home exercises and provided practical tips for gathering materials. No additional therapist contact was planned. The homework session typically lasted 30 minutes, but was extended to one hour with the child creating a drawing of a proud moment from the exposure session.

Participants in the OST + app condition received instructions for the app-based homework program. Thirty personalized exposure exercises (10 per difficulty level) and 10 rewards were created collaboratively by the therapist and child, with parents assisting when needed (see Chapter 2). The homework session typically lasted 1.5 hours. To support app use and encourage practice, therapists conducted 15-minute phone or video check-ins at the end of each of the first three home-practice weeks; the fourth week concluded with the standard in-clinic assessment. Participants in both conditions were informed that they could contact the therapist in case of significant problems during home practice.

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<sup>1</sup> Other measures not analyzed in this study are detailed in Chapter 3

The intervention was delivered by 27 therapists whose education ranged from bachelor's-level practitioners to those with post-master's degrees. Their clinical experience ranged from six months to 18 years ( $M = 6.48$ ,  $SD = 5.47$ ): 48.15% had between six months and under 5 years of experience, 22.22% had 5 to under 10 years, and 29.63% had 10 years or more. All therapists were trained and supervised by AH, THO, KK, and AB. Training comprised two workshops—one on the OST protocol and procedures, and another on handling complex cases—followed by a supervised practice case. There were no differences between conditions regarding therapist experience ( $W = 3198$ ,  $p = .606$ ) or education level ( $\chi^2(2, N = 166) = 0.132$ ,  $p = .936$ ), based on analyses in which each therapist's experience and education were linked to all children they treated, noting that most therapists delivered treatment in both conditions.

Treatment sessions were recorded, and exposure session recordings from 33 randomly selected participants (20%) were scored for treatment integrity and therapist competence. Scoring was conducted by trained assessors using a previously established checklist (Ollendick et al., 2009). The checklist included 11 items rated from 0 (not at all) to 6 (excellent). Mean therapist competency was 5.54 ( $SD = 0.34$ ; range 4.36–5.91).

## Procedure

At baseline (T1), children and parents completed diagnostic interviews and questionnaires. Three weeks later, families returned for the pre-treatment assessment and cognitive-behavioral analysis (T2), during which primary outcomes were reassessed and the BAT was administered. One week later, children attended the three-hour exposure session (T3), after which randomization occurred. One week post-exposure, families returned for the post-OST assessment and homework instructions (T4), followed by four weeks of home practice and a post-practice assessment and evaluation (T5). Children with additional problems were referred for further care. Those still meeting criteria for specific phobia were encouraged to continue practicing for two additional 4-week periods and were offered up to two booster OST sessions (16 participants [10%] used this option; see Figure 1). Children with persistent complaints after boosters were referred to regular care. Five months after T5 (six months after exposure), families completed a follow-up assessment (T6). Children received a certificate at T5 and a small gift (€5) at T6. Figure 1 shows the CONSORT flowchart, and an overview of measures per assessment is provided in Chapter 3.

## Data analysis

Primary and secondary outcomes were analyzed using mixed-effects multilevel linear models for continuous outcomes and generalized mixed models for categorical outcomes (remission). Reporter (child vs. parent) and its interaction with time were also included in the relevant models. Maximal random effects structures were specified following Barr et al. (2013) and the study protocol (Chapter 3). However, due to limited within-subject variation and relatively few observations, models including random slopes failed to converge or were

simplified. Consequently, all models included fixed effects with random intercepts. All variables were standardized and as such the parameter estimates can be interpreted as a measure of effect (Cohen's  $d$ : 0.30 is small, 0.50 is medium, 0.80 is large).

Two main families of analyses were conducted. The first assessed baseline stability across the two baseline assessments to examine stability during the waiting period. The second assessed treatment effects, examining changes across post-OST, post-practice, and follow-up time-points and differences between treatment conditions. Bonferroni corrections were applied separately to the two main families of primary tests. For baseline stability models (CSR, SDS, AVAC Fear, and AVAC Avoidance), the significance threshold was set to  $\alpha = .05/4 = .0125$ . For treatment effect models (Diagnosis, CSR, BAT, SDS, AVAC Fear, and AVAC Avoidance), the threshold was  $\alpha = .05/6 = .0083$ .

Mixed-effects multilevel linear models use all available data, including the data from families with incomplete assessments. Missingness was low at baseline (<2–5%) and increased at later follow-ups (up to ~14–27% at T7, depending on the variable). Patterns of missing data were examined to evaluate whether data were missing completely at random (MCAR) or missing at random (MAR). Little's MCAR test could not be conducted for most outcomes due to highly sparse and heterogeneous missingness patterns; where feasible, the test did not provide evidence against MCAR. Logistic regressions predicting missingness from baseline scores showed no significant associations for any outcome, indicating that missing data were likely MAR.

Per-protocol analyses were conducted in two steps to assess the robustness of the findings. First, four participants completing fewer than four (out of 30) practice exercises in the app were excluded from the OST + app condition. Second, analyses were repeated excluding three additional participants in the OST + app condition whose app setup was incomplete (e.g., missing exercises or rewards). These exclusions did not meaningfully alter the results; therefore, findings reported below are based on the full sample.

Model assumptions were evaluated for all outcomes. CSR and diagnosis models showed no violations. AVAC models displayed mild deviations from normality, which were deemed unproblematic given the large sample size. The BAT and SDS models showed minor deviations from normality and significant heteroscedasticity (Breusch–Pagan test,  $p < .001$ ). To account for these violations, cluster-robust standard errors (CR2 estimator; Satterthwaite approximation) were used when reporting BAT and SDS results. The robust estimates did not change the pattern or interpretation of the main results.

Exploratory analyses evaluating condition differences in homework practice frequency, treatment satisfaction, and treatment experiences (using, respectively, chi-square tests, indepen-

dent-samples *t*-tests, and descriptive statistics) were conducted to further contextualize the results. A *p* value < .05 was considered significant for exploratory analyses.

## RESULTS

### Baseline Stability

At baseline (T1) and pre-treatment (T2), all participants met diagnostic criteria for their primary specific phobia, indicating no change in diagnosis during the waiting period. Model statistics are presented in Table 2. There were no significant changes in phobia severity (CSR), impairment (SDS), or avoidance (AVAC Avoidance) during the baseline period. However, self-reported fear (AVAC Fear) decreased significantly from T1 to T2 ( $b = -0.218$ ,  $SE = 0.085$ ,  $p = .001$ ), reflecting a small reduction in self-reported fear prior to treatment onset. The results suggest that children’s clinical status remained largely stable during the waiting period, with only a modest early reduction in self-reported fear.

**Table 2**  
*Baseline Stability Mixed-Effects Models: Fixed Effects of Time on Clinical Outcomes for Pre-treatment with Intake as Reference Category for Available Primary (CSR) and Secondary (SDS, AVAC Fear and AVAC Avoidance) Measures*

| Outcome        | Estimate (Time) | SE    | df     | <i>t</i> | <i>p</i> |
|----------------|-----------------|-------|--------|----------|----------|
| CSR            | 0.026           | 0.048 | 160.47 | 0.54     | .592     |
| SDS            | 0.076           | 0.067 | 167    | 1.14     | .255     |
| AVAC Fear      | -0.218          | 0.085 | 166    | -3.27    | .001**   |
| AVAC Avoidance | -0.170          | 0.10  | 165    | -2.07    | .040     |

*Note.* SEs for SDS, AVAC Fear, and AVAC Avoidance are cluster-robust (CR2) and *t*-tests use Satterthwaite degrees of freedom to address model assumption violations. CSR uses standard SEs. Significance is assessed against a Bonferroni-corrected threshold  $\alpha = .05/4 = 0.0125$  (\*),  $p < .01$  (\*\*). Variables are standardized and as such parameter estimates can be interpreted as effect sizes.

### Treatment Effect

Results for the primary and secondary outcomes can be found in Tables 3a and 3b. Across the full sample, 25.2% of children were diagnosis-free at post-OST (T4), 46.0% at post-practice (T5), and 69.6% at 6-month follow-up (T6). Similar remission trajectories were observed for both conditions: in the OST-only group, 21.8%, 43.6%, and 68.5% were diagnosis-free at T4, T5, and T6, compared with 28.2%, 48.2%, and 70.7% in the OST + app group.

Across all outcomes, significant time effects indicated reductions in phobia severity (CSR), specific phobia diagnosis, avoidance behaviors (BAT), self-reported fear and avoidance (AVAC), and functional impairment (SDS), with medium to large effect sizes and gains maintained through post-practice and 6-month follow-up. See supplementary Tables S1a

and S1b for an overview of the means and standard deviations of all outcome measures at all timepoints. No significant condition  $\times$  time interaction effects were observed, indicating that the trajectories of change did not differ between conditions. Significant reporter  $\times$  time interactions emerged in AVAC fear and avoidance at post-practice and follow-up: both parents and children reported reductions, with parents reporting larger improvements. Overall, substantial and sustained changes were observed, with the app-based homework program not altering outcomes.

**Table 3a**

*Mixed-Effects Model Estimates Comparing Posttreatment, Post-practice, and 6-Month Follow-Up to Second Baseline (Pre-Treatment) for the Primary Outcomes*

| Predictor             | Diagnosis     |            | Phobia Severity (CSR) |            |
|-----------------------|---------------|------------|-----------------------|------------|
|                       | Estimate (SE) | <i>p</i>   | Estimate (SE)         | <i>p</i>   |
| (Intercept)           | 2.04 (0.45)   | < .001 *** | 0.83 (0.09)           | < .001 *** |
| Condition (App)       | -0.44 (0.56)  | .433       | 0.07 (0.13)           | .572       |
| T4 (post)             | NA            | NA         | -0.73 (0.10)          | < .001 *** |
| T5 (postpractice)     | -1.61 (0.48)  | < .001 *** | -1.11 (0.10)          | < .001 *** |
| T6 (follow-up)        | -3.37 (0.57)  | < .001 *** | -1.54 (0.10)          | < .001 *** |
| Condition $\times$ T4 | NA            | NA         | -0.07 (0.13)          | 0.596      |
| Condition $\times$ T5 | 0.13 (0.62)   | .0841      | -0.09 (0.13)          | 0.491      |
| Condition $\times$ T6 | 0.27 (0.68)   | .695       | -0.11 (0.14)          | 0.450      |

*Note.* CSR = Clinician Severity Rating; Diagnosis = Specific phobia diagnosis (binary); BAT = Behavioral Approach Task. Time predictors are referenced against T2 (second baseline). Significance is assessed against a Bonferroni-corrected threshold  $\alpha = .05/6 = .0083$  (\*),  $p < .001$  (\*\*\*). Variables are standardized and as such parameter estimates can be interpreted as effect sizes. Since diagnosis is a binary outcome a GLMER model was fitted for this variable. Because all participants had a phobia diagnosis at the second baseline it could not be included in the model due to a lack of variance. Therefore, a Fisher's test was performed to establish improvement between T2 and T4 (no group differences) and T4 was used as the reference category for this GLMER model.

Table 3b

Mixed-Effects Model Estimates Comparing Posttreatment, Postpractice, and 6-Month Follow-Up to Second Baseline (pre-treatment) for Secondary Outcomes

| Predictor                 | BAT           |            | SDS           |            | AVAC Fear     |            | AVAC Avoidance |            |
|---------------------------|---------------|------------|---------------|------------|---------------|------------|----------------|------------|
|                           | Estimate (SE) | p          | Estimate (SE) | p          | Estimate (SE) | p          | Estimate (SE)  | p          |
| (Intercept)               | -0.81 (0.12)  | < .001 *** | 0.23 (0.13)   | .076       | 0.56 (0.09)   | < .001 *** | 0.49 (0.10)    | < .001 *** |
| Time T4 (post)            | 0.99 (0.13)   | < .001 *** | -0.44 (0.10)  | < .001 *** | -0.61 (0.10)  | < .001 *** | -0.46 (0.11)   | < .001 *** |
| Time T5 (postpractice)    | 1.02 (0.13)   | < .001 *** | -0.51 (0.12)  | < .001 *** | -0.84 (0.10)  | < .001 *** | -0.71 (0.11)   | < .001 *** |
| Time T6 (follow-up)       | 1.15 (0.14)   | < .001 *** | -0.63 (0.12)  | < .001 *** | -1.22 (0.10)  | < .001 *** | -1.02 (0.11)   | < .001 *** |
| Condition (App)           | -0.19 (0.17)  | 0.265      | 0.03 (0.17)   | .884       | 0.10 (0.13)   | .456       | -0.10 (0.13)   | .456       |
| Reporter (Parent)         | NA            | NA         | 0.31 (0.16)   | .057       | 0.46 (0.10)   | < .001 *** | 0.53 (0.11)    | < .001 *** |
| T4 × Condition            | -0.18 (0.17)  | .284       | 0.18 (0.15)   | .247       | -0.16 (0.14)  | .265       | -0.14 (0.15)   | .362       |
| T5 × Condition            | -0.04 (0.17)  | .804       | 0.01 (0.16)   | .969       | -0.24 (0.14)  | .090       | -0.17 (0.15)   | .281       |
| T6 × Condition            | -0.11 (0.19)  | .542       | -0.08 (0.16)  | .640       | -0.24 (0.14)  | .090       | -0.16 (0.16)   | .298       |
| T4 × Reporter             | NA            | NA         | 0.20 (0.16)   | .0213      | -0.26 (0.14)  | .066       | -0.25 (0.16)   | .119       |
| T5 × Reporter             | NA            | NA         | -0.09 (0.18)  | .610       | -0.46 (0.14)  | .001 *     | -0.51 (0.16)   | .001 *     |
| T6 × Reporter             | NA            | NA         | -0.19 (0.16)  | .242       | -0.44 (0.15)  | .003 *     | -0.55 (0.16)   | < .001 *** |
| Condition × Reporter      | NA            | NA         | -0.07 (0.20)  | .712       | -0.05 (0.14)  | .711       | 0.08 (0.15)    | .607       |
| T4 × Condition × Reporter | NA            | NA         | -0.06 (0.21)  | .793       | 0.35 (0.20)   | .078       | 0.33 (0.22)    | .136       |
| T5 × Condition × Reporter | NA            | NA         | 0.16 (0.22)   | .481       | 0.25 (0.20)   | .220       | 0.08 (0.22)    | .718       |
| T6 × Condition × Reporter | NA            | NA         | 0.06 (0.21)   | .770       | 0.10 (0.20)   | .641       | 0.06 (0.22)    | .776       |

Note. SDS = Self-rated Disability Scale; AVAC = Avoidance and Fear Questionnaire for Children. SEs for BAT, and SDS are cluster-robust (CR2) and t-tests use Satterthwaite degrees of freedom to address model assumption violations. Time predictors are referenced against T3 (second baseline). Significance is assessed against a Bonferroni-corrected threshold  $\alpha = .05/6 = .0083$  (\*),  $p < .001$  (\*\*\*). Variables are standardized and as such parameter estimates can be interpreted as effect sizes.

## Exploratory Analyses

### *Homework Compliance*

Most families retrospectively indicated that children practiced two to five times per week (scale: 1 = several times a day to 7 = not at all; see supplementary Table S2 for details). Specifically, 38% of parents and 36% of children reported practicing two or three times per week, and 25% of parents and 24% of children reported practicing four or five times per week. Very few indicated daily practice ( $\leq 6\%$ ) or no practice at all ( $\approx 3\%$ ). Chi-square tests indicated no significant differences between OST-only and OST + app in practice frequency for child report,  $\chi^2(4) = 8.53$ ,  $p = .074$ , or parent report,  $\chi^2(4) = 5.75$ ,  $p = .218$ . These findings suggest that children in both groups engaged in similar amounts of homework practice.

### *Treatment Satisfaction*

Treatment satisfaction was significantly higher in the OST + app condition compared to the OST-only group for both child report,  $t(142) = -2.34$ ,  $p = .021$ ,  $d = 0.38$ , and parent report,  $t(130) = -2.48$ ,  $p = .015$ ,  $d = 0.41$ . See supplementary Table S3 for means and standard deviations. Notably, one-third of parents and children in the OST + app condition reported experiencing some form of technical difficulty, ranging from minor inconveniences (e.g., having to re-enter the password) to more serious problems (e.g., inability to load photos or login failures).

### *Blood-Injection-Injury Phobias*

We conducted an exploratory analysis comparing children with blood-injection-injury (BII) phobias to those with other phobias, given the high proportion of BII cases in our sample (40%) and their common exclusion from previous studies. Post-OST remission rates did not differ significantly between groups (26.6% versus 24.2%),  $\chi^2(1, N = 166) = 0.02$ ,  $p = .882$ . Post-practice, remission was significantly lower for children with BII phobias (33.9%) than for those with non-BII phobias (53.5%),  $\chi^2(1, N = 165) = 5.18$ ,  $p = .023$ , with the difference increasing at 6-month follow-up (52.7% versus 79.6%),  $\chi^2(1, N = 160) = 10.53$ ,  $p = .001$ . Homework frequency did not significantly differ between groups based on child report,  $\chi^2(4, N = 151) = 1.75$ ,  $p = .782$ , or parent report,  $\chi^2(4, N = 148) = 0.78$ ,  $p = .941$  (Fisher's exact  $p = .948$ ).

## DISCUSSION

This study compared standard OST to OST supplemented with an app-based homework program for childhood specific phobias and aimed to replicate OST effects in Dutch and German samples. Both treatment groups showed substantial and sustained reductions in phobia severity, diagnosis rates, behavioral avoidance, self-reported fear and avoidance, and functional impairment, while symptoms remained largely stable during the baseline period,

supporting OST's efficacy. These findings are consistent with prior controlled trials of OST for childhood phobias (e.g., Ollendick et al., 2009; Ollendick et al., 2015; Ollendick & Davis, 2013; Seligman & Ollendick, 2011). Contrary to our hypothesis, the app-based homework program did not enhance clinical outcomes, although both children and parents reported higher treatment satisfaction in the OST + app condition.

Previous attempts to enhance OST—including intensive parent components, priming with attention training, and pharmacological enhancers such as D-cycloserine—have generally shown limited or no additional benefits (e.g., Farrell et al., 2018; Ollendick et al., 2015; Öst et al., 2001; Waters et al., 2014), and our findings are consistent with this broader pattern. A possible reason why the higher levels of treatment satisfaction in the OST + app condition did not translate into enhanced clinical outcomes may be because homework practice levels were similar across groups, and children in both groups practiced frequently—often 2–5 times per week. The current sample may have been highly motivated, as further indicated by their willingness to participate in extensive study assessments. The level of engagement could also reflect a core strength of OST: its short and high-intensity format allows children to experience rapid gains, which in turn may enhance motivation to practice at home. In prior CBT studies, homework compliance is typically lower (e.g., only 31.5% of youth completed at least one activity per session in Coping Cat; Lee et al., 2019), which suggests relatively high engagement among participants in the present study. However, comparing homework engagement across studies and treatment formats is challenging, as little is known about typical practice levels following OST. It is possible that the app resulted in clinically meaningful results for families with lower motivation or less parental involvement by providing more structure and guidance for practice. Further studies could examine for which subgroups app-based augmentation may prove beneficial.

While our findings generally align with prior OST trials demonstrating substantial improvements in symptom severity and diagnostic remission, the remission rates in the present study differed somewhat from earlier work (e.g., Ollendick et al., 2015: 35.4% post-OST, 56.4% post-practice, 67.4% at follow-up; current study: 25.2%, 46.0%, and 69.6%, respectively). The relatively lower post-OST remission rate in the present study may reflect the scoring approach used, which relied on the highest CSR score from the parent and child interviews rather than a consensus score. Considering parents did not observe the exposure session, their ratings may have been based on outdated impressions, inflating post-OST severity. Indeed, when parent and child scores were inspected separately, remission at post-OST was higher according to child reports (child: 41.6%; parent: 30.4%). A consensus-based approach—such as used in the study by Ollendick et al. (2015)—might therefore have produced higher remission estimates. After the practice period, remission rates were comparable between parent and child ratings.

The remission rates found in the current study are particularly noteworthy given the unusually high proportion of children with BII phobias (predominantly injection phobias), which are frequently excluded in previous OST trials, often for practical reasons such as limited availability of medical staff on site (e.g., Ollendick et al., 2009, 2015). Consistent with earlier findings (Öst et al., 2001), children with injection phobia in the current study were less likely to be diagnosis-free at post-practice and follow-up. Removing these cases increased overall remission rates, highlighting the influence of sample composition on outcome comparisons across studies. Unlike other specific phobias—in which meaningful functional gains may occur even when some fear remains (e.g., being able to walk past dogs while still avoiding direct contact)—recovery from injection phobia typically requires successful completion of the feared procedure, making full remission more difficult to achieve. Although children with BII phobia seemed to have practiced as frequently as those with other phobias, arranging real-life exposure is more logistically challenging (e.g., requiring access to medical staff), so practice often focused on preparatory steps or simulations rather than the injection itself. This may help explain the widening gap in remission rates between injection phobias and other phobias after the practice period. Nonetheless, even within the BII group, more than half of children were diagnosis-free at follow-up, which is clinically meaningful, especially considering that in many contexts—including the Netherlands and Germany—these children often receive no psychological treatment and instead rely on sedation or avoidance. Thus demonstrating that OST can produce substantial gains even for phobia subtypes that are frequently understudied, undertreated, and less responsive to standard care (McMurtry et al., 2016; Oar et al., 2015).

The present study has several strengths. To our knowledge, it is the largest trial of supplemented OST to date, conducted internationally across multiple community and university clinics. Therapists varied in experience, and all phobia types and comorbidities were included, strengthening ecological validity. Rigorous assessor training, masking, and high treatment integrity and interrater reliability further support the robustness of the findings. Another strength is the evaluation of a theoretically informed, user-collaboratively developed app that incorporates key components of effective homework (Chapter 2). Although the app did not enhance outcomes, its systematic development and assessment strengthen the study's contribution to the digital mental health literature. A further strength is the comprehensive multi-informant and multi-method assessment—child, parent, and clinician interviews; behavioral avoidance tests; impairment ratings; and individualized goals—consistent with recommended measurement practices for treatment trials (Creswell et al., 2021). This approach also generated a rich dataset, enabling future moderator and subgroup analyses (e.g., BII phobia) and more detailed examination of mechanisms such as homework engagement.

Several limitations should also be noted. European regulations required deactivation of the app after the 4-week practice phase, as the therapist did not have enough monitoring access beyond this period, preventing evaluation of whether the app might support continued

practice at home. Children in the OST + app condition also received more therapist contact (three brief check-ins and a longer homework session), which—although not associated with differences in clinical outcomes—may partially explain higher treatment satisfaction reported in this group. In addition, technical issues and the inclusion of research-related questions within the app may have reduced engagement for some children.

In sum, this study replicates the strong efficacy of OST for childhood specific phobias and extends prior research by evaluating a supplemental app-based homework program. Although the app-supported program did not enhance clinical outcomes, it was associated with higher treatment satisfaction. The high proportion of injection phobia cases highlighted specific challenges in achieving full remission for this group, underscoring the need for tailored approaches. Overall, OST remains a robust, efficient, and scalable intervention. Future work should continue to examine how digital tools and targeted adaptations can optimize outcomes across phobia subtypes, while also expanding access to (standard) OST, and further clarify the role of homework in OST and CBT more broadly.

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SUPPLEMENTARY MATERIALS CHAPTER 4

Table S1a

*Descriptives of the Primary Outcome Measures at the Different Timepoints*

| Predictor          | Diagnosis<br>% |          |           | Phobia Severity (CSR)<br>Mean (SD) |             |             |
|--------------------|----------------|----------|-----------|------------------------------------|-------------|-------------|
|                    | Full sample    | OST-only | OST + app | Full sample                        | OST-only    | OST + app   |
| Intake (T1)        | 100            | 100      | 100       | 5.84 (1.11)                        | 5.84 (1.05) | 5.81 (1.17) |
| Pre-treatment (T2) | 100            | 100      | 100       | 5.88 (1.09)                        | 5.81 (1.06) | 5.93 (1.11) |
| Post-OST (T4)      | 74.8           | 78.2     | 71.8      | 4.32 (1.52)                        | 4.35 (1.31) | 4.29 (1.70) |
| Postpractice (T5)  | 54.0           | 56.4     | 51.8      | 3.56 (1.81)                        | 3.56 (1.51) | 3.56 (2.05) |
| Follow-up (T6)     | 30.4           | 31.5     | 29.3      | 2.70 (1.95)                        | 2.73 (1.95) | 2.67 (1.97) |

*Note.* Diagnosis is reported as percentage of participants meeting criteria. CSR is the Clinician Severity Rating where scores of 4 or higher are seen as clinical.

**Table S1b**

*Means and Standard Deviations of the Secondary Outcome Measures at the Different Timepoints*

| Predictor          | BAT           |               |               | SDS child report |             |             | SDS parent report |             |             |
|--------------------|---------------|---------------|---------------|------------------|-------------|-------------|-------------------|-------------|-------------|
|                    | Full sample   | OST-only      | OST + app     | Full sample      | OST-only    | OST + app   | Full sample       | OST-only    | OST + app   |
| Intake (T1)        | NA            | NA            | NA            | 2.02 (1.89)      | 1.88 (1.90) | 2.15 (1.93) | 2.72 (1.97)       | 2.74 (2.00) | 2.67 (1.99) |
| Pre-treatment (T2) | 48.62 (38.11) | 44.45 (38.39) | 52.01 (37.37) | 2.16 (1.94)      | 2.17 (1.98) | 2.19 (1.95) | 2.65 (2.02)       | 2.71 (2.01) | 2.60 (2.05) |
| Post-OST (T4)      | 80.25 (32.65) | 80.36 (32.61) | 80.13 (32.89) | 1.57 (1.75)      | 1.38 (1.59) | 1.74 (1.89) | 2.3 (1.85)        | 2.26 (1.7)  | 2.37 (1.97) |
| Postpractice (T5)  | 83.58 (30.25) | 81.29 (32.58) | 85.75 (27.91) | 1.28 (1.54)      | 1.27 (1.61) | 1.28 (1.48) | 1.71 (1.67)       | 1.66 (1.53) | 1.76 (1.81) |
| Follow-up (T6)     | 86.58 (27.95) | 85.40 (30.09) | 87.81 (25.71) | 0.99 (1.23)      | 1.07 (1.25) | 0.90 (1.22) | 1.16 (1.34)       | 1.27 (1.34) | 1.06 (1.34) |

*Note.* BAT is reported as percentage of steps completed, a higher percentage means less avoidance. The SDS scale ranges from 0 (not at all) to 3 (very much) impairment.

Table S1b *Continued*

| Predictor             | AVAC Fear<br>child report |             |             | AVAC Fear<br>parent report |             |             | AVAC Avoidance<br>Child report |             |             | AVAC Avoidance<br>Parent report |             |             |
|-----------------------|---------------------------|-------------|-------------|----------------------------|-------------|-------------|--------------------------------|-------------|-------------|---------------------------------|-------------|-------------|
|                       | Full<br>sample            | OST-only    | OST + app   | Full<br>sample             | OST-only    | OST + app   | Full<br>sample                 | OST-only    | OST + app   | Full<br>sample                  | OST-only    | OST + app   |
| Intake<br>(T1)        | 3.94 (0.66)               | 3.89 (0.69) | 3.96 (0.64) | 4.30 (0.51)                | 4.26 (0.58) | 4.36 (0.44) | 3.77 (0.96)                    | 3.84 (0.95) | 3.72 (0.96) | 4.31 (0.66)                     | 4.39 (0.64) | 4.25 (0.68) |
| Pre-treatment<br>(T2) | 3.80 (0.76)               | 3.74 (0.76) | 3.85 (0.76) | 4.28 (0.53)                | 4.26 (0.51) | 4.30 (0.55) | 3.62 (0.99)                    | 3.68 (0.94) | 3.57 (1.05) | 4.31 (0.66)                     | 4.33 (0.60) | 4.32 (0.71) |
| Post-OST<br>(T4)      | 2.99 (1.00)               | 3.01 (0.98) | 2.95 (1.01) | 3.39 (0.99)                | 3.25 (0.97) | 3.52 (1.00) | 2.93 (1.15)                    | 3.08 (1.10) | 2.79 (1.17) | 3.55 (1.06)                     | 3.44 (1.06) | 3.65 (1.07) |
| Postpractice<br>(T5)  | 2.69 (1.05)               | 2.77 (1.01) | 2.61 (1.09) | 2.80 (1.06)                | 2.78 (1.06) | 2.82 (1.07) | 2.63 (1.07)                    | 2.79 (0.95) | 2.47 (1.16) | 2.76 (1.16)                     | 2.82 (1.10) | 2.69 (1.22) |
| Follow-up<br>(T6)     | 2.25 (1.00)               | 2.34 (1.00) | 2.15 (1.01) | 2.30 (0.97)                | 2.37 (0.94) | 2.23 (1.01) | 2.24 (1.15)                    | 2.41 (1.18) | 2.08 (1.10) | 2.31 (1.10)                     | 2.38 (1.14) | 2.23 (1.05) |

*Note.* Both AVAC scales range from 1 (no fear/never avoids) to 5 (very strong fear/always avoids).

**Table S2**  
*Practice Frequency by Condition – Child and Parent Report*  
*Panel A. Child Report*

| Condition | Several times a day | 6–7 times a week | 4–5 times a week | 2–3 times a week | Once a week | Less than once a week | Not at all |
|-----------|---------------------|------------------|------------------|------------------|-------------|-----------------------|------------|
| OST-only  | 4.2                 | 9.9              | 21.1             | 33.8             | 16.9        | 11.2                  | 2.8        |
| OST + app | 7.5                 | 16.2             | 26.2             | 37.5             | 7.5         | 2.5                   | 2.5        |

*Panel B. Parent Report*

| Condition | Several times a day | 6–7 times a week | 4–5 times a week | 2–3 times a week | Once a week | Less than once a week | Not at all |
|-----------|---------------------|------------------|------------------|------------------|-------------|-----------------------|------------|
| OST only  | 0.0                 | 17.4             | 20.3             | 34.8             | 17.4        | 5.8                   | 4.3        |
| OST + app | 2.3                 | 13.8             | 26.4             | 36.8             | 8.0         | 2.3                   | 1.1        |

*Note.* Values represent percentages of participants within each condition. Child-report percentages exclude missing data (n = 21); parent-report percentages exclude missing data (n = 24).

**Table S3***Treatment Satisfaction Ratings About the Homework Period (Parent and Child Report)**Panel A. Child Report*

| Question                                                                                      | OST-only |           | OST + app |           |
|-----------------------------------------------------------------------------------------------|----------|-----------|-----------|-----------|
|                                                                                               | <i>M</i> | <i>SD</i> | <i>M</i>  | <i>SD</i> |
| I have learned a lot from the home practice program.                                          | 3.93     | 0.92      | 4.21      | 0.81      |
| I would advise other children with similar complaints to participate in the homework program. | 4.41     | 0.85      | 4.49      | 0.81      |
| The homework program has helped me overcome the fear.                                         | 3.89     | 1.02      | 4.23      | 0.87      |
| I am satisfied with the homework program I got.                                               | 4.06     | 0.89      | 4.46      | 0.78      |
| I am satisfied with the therapist who helped me prepare the homework program.                 | 4.76     | 0.55      | 4.83      | 0.41      |
| Global satisfaction with the homework program<br>(1 = very bad to 10 = very good)             | 7.62     | 1.97      | 8.34      | 1.78      |

*Panel B. Parent Report*

| Question                                                                                                    | OST Only |           | App      |           |
|-------------------------------------------------------------------------------------------------------------|----------|-----------|----------|-----------|
|                                                                                                             | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> |
| How do you rate the quality of the practice program your child has received the last 4 weeks at home?       | 3.46     | 0.88      | 4.05     | 0.80      |
| To what extent has the practice program your child did at home met your child's needs?                      | 3.68     | 0.99      | 4.14     | 0.76      |
| To what extent has the practice program your child did at home met your needs?                              | 3.57     | 0.95      | 3.97     | 0.83      |
| Has the practice program your child did at home helped you deal with your child's anxiety more effectively? | 3.80     | 1.01      | 3.92     | 0.92      |
| My child has learned a lot from the practice program in the last 4 weeks.                                   | 4.03     | 0.98      | 4.31     | 0.78      |
| I would advise other parents of children with similar complaints to participate in a similar program.       | 4.40     | 0.76      | 4.66     | 0.66      |
| The 4-week home practice program has helped my child overcome the fear.                                     | 3.93     | 0.93      | 4.18     | 0.80      |
| I am satisfied with the home practice program my child has had.                                             | 4.01     | 0.90      | 4.33     | 0.75      |
| I am satisfied with the therapist who helped my child prepare the home practice program.                    | 4.74     | 0.53      | 4.86     | 0.42      |
| Global satisfaction with the homework program<br>(1 = very bad to 10 = very good)                           | 7.51     | 1.63      | 8.11     | 1.30      |

*Note.* All except the global satisfaction item were rated 1 = completely disagree to 5 = completely agree.

