

Effectiveness of online responsive teaching in young children with developmental disabilities: a pilot study

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Background: Responsive teaching (RT) interventions, which enhance developmental outcomes by improving children's engagement behaviors, are traditionally delivered in person. However, the coronavirus disease 2019 pandemic complicated this approach.

Purpose: This study aimed to evaluate the efficacy and acceptance of online RT in children with developmental disabilities and their parents.

Methods: This pilot study was conducted in Jinju, South Korea, and enrolled parent-child dyads referred to Gyeongsang National University Hospital for developmental concerns between April and September 2022. The children underwent a comprehensive developmental evaluation. The parents received a 5-session RT intervention via ZOOM on a mostly weekly basis. The first 2 sessions involved child development and RT lectures, while the others involved coaching on 3 of the 66 RT strategies. Problem behaviors, parent-child interactions, and parenting stress were assessed pre- versus postintervention using the Korean versions of the Child Behavior Checklist, Maternal/Child Behavior Rating Scale, and Parent Stress Index 4th Edition Short Form, respectively. Acceptability was evaluated using a self-administered questionnaire.

Results: Of the 30 recruited parent-child pairs, 23 (76%) completed the intervention and assessments. The children (mean age, 2.66±0.86 years) included 12 with language delays, 7 with autism spectrum disorder, and 4 with global delays. Predominantly mothers (96%) participated. Online RT significantly improved pivotal behaviors—including joint attention ($P=0.04$), cooperation ($P=0.01$), and affect ($P=0.01$)—and reduced overall problem behaviors ($P=0.04$). Parents reported less parenting stress ($P=0.01$), improved interactive behaviors with increased responsiveness ($P<0.01$), and decreased directiveness ($P<0.01$). High satisfaction with online RT interventions was also previously reported.

Conclusion: These findings suggest that online RT can improve children's emotional and behavioral outcomes and maternal interaction styles and reduce parenting stress, offering accessible interventions amid challenges such as limited access and pandemics.

Key words: Internet-based intervention, Developmental disabilities, Infant, Mother-child relations

Key message

Question: Does online responsive teaching (RT) impact children's and parents' emotions and behaviors, and do parents find it satisfactory?

Finding: Online RT significantly improved children's pivotal and problem behaviors, decreased parenting stress, and enhanced parental interactive styles with high satisfaction.

Meaning: This pilot study's findings suggest that online RT can enhance child outcomes, offering accessible interventions amid challenges such as limited access and pandemics.

Introduction

Developmental disorders affect approximately 5%–10% of the childhood population.¹ Early screening, diagnosis and intervention are crucial during early childhood owing to the brain's remarkable plasticity.² Korea's National Health Screening Programme for Infants and Children, initiated in 2007, has improved early detection, with up to 45% of cases identified before the age of 2 years.³ However, timely and effective interventions remain challenging, compounded by extended waiting times of up to 1–2 years and parental dissatisfaction due to a lack of feedback and parental support.³ Furthermore, the availability of rehabilitative services for infants under 2 years of age is notably limited.³

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These challenges highlight the need to bridge the gap between diagnosis and treatment, particularly in young infants.

The coronavirus disease 2019 (COVID-19) pandemic has exacerbated these issues, leading to a 50% reduction in the utilization of developmental rehabilitation centers and suspension of services in 70% of welfare facilities in Korea during the pandemic.⁴⁾ The lack of access to rehabilitation services during the pandemic was a global issue, particularly impacting interventions requiring direct interaction between the child and the therapist.⁵⁾ Telehealth is an innovative alternative for early childhood developmental care, offering remote service delivery.^{6,7)} Extensive evidence supports its effectiveness in enhancing children's social communication, reducing challenging behaviors, and alleviating parenting stress.⁸⁻¹⁰⁾ Most tele-intervention studies prefer a family-centered model, focusing on educating and training parents rather than direct child intervention.¹¹⁾ This preference arises from the limitations of online environments for direct child interventions and the benefits of the family-centered educational model. Research indicates that family-centered approaches involving parents have a more positive impact on early childhood development than individualized therapy or institutional education.¹²⁾ This may be because learning is more effective in natural settings and routine activities than in professionally directed learning activities.¹³⁾ Additionally, children interact more frequently with their parents, exceeding the one-on-one interactions provided in therapy and special education.¹²⁾ However, despite the strengths of family-centered approaches with parental involvement, they have not gained widespread support from Korean developmental rehabilitation services.

The growing demand for family-centered telehealth services for infants and toddlers with developmental disabilities is evident. We propose that responsive teaching (RT), a family-centered approach enhancing cognition and communication in infants and toddlers, can effectively address these needs. This proposition is grounded in 3 key factors. First, RT's efficacy is well-established in traditional in-person interventions.¹⁴⁻¹⁸⁾ RT encourages parents to engage in highly responsive interactions with their children during daily activities, improving pivotal behaviors critical for development, such as initiation, joint attention, and cooperation.¹⁹⁾ Parents' enhanced responsive behaviors contribute to the cultivation of these pivotal behaviors in children, thereby fostering improved developmental outcomes.²⁰⁾ Second, RT lends itself to online delivery due to its inherent structure, including personalized feedback and home-based action plans, which are associated with the effective adoption of telehealth interventions.²¹⁾ Third, RT is designed for young infants and children,¹⁴⁾ and has been

successfully applied even at 12 months of age.²²⁾ Despite these strengths, currently, no studies have examined the effectiveness of online RT as a telehealth intervention.

This pilot study explored the effectiveness and acceptability of online RT interventions in young infants and children with various developmental disabilities. Owing to the brief duration of the sessions in this pilot study, our primary focus was on observing changes in the behavior and emotions of children and parents rather than specific developmental outcomes. Two questions guided this study:

How does online RT affect children's pivotal behavior, problem behavior, parental interactive behavior, and parenting stress in terms of effectiveness?

What is the level of parental satisfaction with online RT in terms of its acceptability?

This study offers valuable telehealth interventions for young children with developmental disabilities, aiming to expand accessible services for families and address challenges, including unmet needs in Korea's current rehabilitation services and pandemic-related geographical and social barriers probably those exacerbated by the pandemic.

Methods

1. Study design and setting

The pilot study was conducted in Jinju, South Korea. Participants were recruited from the Pediatric Development Clinic of Gyeongsang National University Hospital between April 2022 and September 2022. This clinic notably serves as an exclusive referral center in western Gyeongsangnam-do for further assessments under the National Health Screening Program for Infants and Children in Korea. This study was reviewed and approved by the Institutional Review Board of Gyeongsang National University of Hospital (GNUH IRB 2022-01-034). Following a comprehensive explanation of the study procedure, including discussions about its benefits, risks, and potential data utilization, informed written consent was obtained from all parents.

2. Participants

The study recruited parent-child dyads who met specific criteria: (1) children referred for evaluation due to suspected developmental delay in the National Health Screening Program for Infants and Children in Korea; (2) parents with internet access for online sessions and surveys; (3) parents living with the children during the intervention period; (4) parents completing all program sessions and assessments; (5) infants undergoing a comprehensive developmental evaluation. Exclusions included: (1) alternating participation of mother or father, and (2) refusal or

discontinuation of participation or evaluation.

Out of 35 children referred for assessment during the study period, initially, 30 parent-child dyads agreed to participate, resulting in an 85.7% recruitment rate. Of these, 3 parents did not complete the full intervention program, achieving a 90% participation rate among initiators. Postintervention outcome measurements and acceptability questionnaires were requested from 27 participants who completed the intervention sessions. However, 3 participants did not comply with outcome measurements, and one did not complete the acceptability questionnaire. In the end, 23 participants were included in the final analysis, resulting in a 76% retention rate.

3. Procedures

A pediatric neurologist evaluated referred children at the Pediatric Development Clinic, interviewing their parents. The program was introduced to interested parents, who were directed to the research coordinator for additional information. Participants opting to join underwent a pre-test assessment, followed by a 5-session RT curriculum delivered through real-time 1:1 online interactions lasting about 30 minutes to an hour via the ZOOM application. To ensure consistency, a certified interventionist trained by a Korean RT center conducted all sessions. After completing online sessions, participants returned to the clinic for feedback, including diagnostic evaluation results for developmental delays, and posttest assessments. The interval between pre- and posttest assessments was set at 2–4 months, with the research coordinator's assistance.

4. Intervention program

Responsive teaching: The first 2 sessions covered child development principles and RT education. The following 3 sessions followed the Korean RT guide, focusing on enhancing pivotal behavior using one RT strategy per session. Among 66 available RT strategies, 3 basics were employed in this study: 'get into the child's world,' 'follow the child's lead,' and 'act and communicate in the child's way.'

During each session, the interventionist: (1) explained the purpose and rationale, linking pivotal behavior to the child's developmental concerns; (2) described a specific RT strategy for parents, explaining how to incorporate it into their daily routines to promote pivotal behavior; (3) coached mothers while they reviewed 10-minute parent-child free play videos at home, which served as homework from the previous session, with the submitted videos providing coaching feedback; (4) assisted mothers in developing family action plans for their routine activities and social interactions with their children.

Each session concluded with a summary and an

introduction to the next session's homework, with time for questions and answers. Due to online limitations, the modeling step of the original RT curriculum, involving the interventionist interacting with the child while providing comments to the mother, was omitted. Detailed session content is outlined in Supplementary Table 1.

5. Outcome measures

The main outcome measures were the effectiveness of the online RT, which were evaluated by pre- and postintervention assessments, including parenting stress, behavioral characteristics of the child, and parent-child interaction. Secondary outcomes included the acceptability of the online RT, which was assessed using a postintervention questionnaire.

6. Demographic questionnaire

General data on child and parent characteristics were collected using a questionnaire before the intervention. The child's characteristics included age, gender, use of childcare facilities, and additional intervention services received, whereas the parent's characteristics included age, marital status, educational level, employment status, and parental role.

7. Assessment of child development

Prior to the intervention, the developmental status and categories of developmental disabilities of the participating children were assessed. Developmental delay was defined as the performance of at least 2 standard deviations below the age-appropriate mean in one or more developmental domains. Developmental delay was further categorized into language delay (delay in language alone), global delay (delay in both language and cognition), and autistic spectrum disorders (ASDs). Language was evaluated using the Bayley Scales of Infants and Toddler-III (Bayley-III) or Preschool Receptive-Expressive Language Scale. Cognition was assessed using the Bayley-III, visuomotor integration, and Korean-Wechsler Preschool and Primary Scale of Intelligence-IV. ASD was evaluated with Korean-Childhood Autism Rating-III, where those with a total score of ≥ 32 were diagnosed with ASD.

In addition to diagnostic tests, the developmental quotient (DQ) (overall developmental age/chronological age \times 100) was obtained by evaluating the overall developmental age using the Korean-Child Developmental Inventory. The DQ was used to evaluate the basic developmental status of the participants prior to the intervention.

8. Effectiveness of online RT: pre- and postintervention outcome assessment

Parenting stress was assessed using the Korean Version

of Parent Stress Index, Fourth Edition Short Form questionnaire,²³⁾ consisting of 36 items grouped into 3 dimensions: (1) parental distress, reflecting personal discomfort with the parenting role; (2) parent-child dysfunctional interaction, assessing meeting expectations and feelings during interactions; and (3) difficult child, focusing on perceptions of the child's temperament or behavior. Participants rated each item on a 5-point Likert scale (1=strongly disagree to 5=strongly agree). The dimensions provided a total parental stress score, with higher scores indicating more distress in parenting. Results included raw scores, percentile ranks, and *T* scores for each dimension, as well as the total stress score. A 'clinically significant' level was defined as the 90th percentile of the Parenting Stress Index – Short Form score. Pretest percentile ranks showed participants' baseline parenting stress, while raw scores were used for analyzing pre- and postintervention changes.

9. Behavioral characteristics of children

The K-CBCL 1.5-5, a Korean adaptation of the Child Behavior Checklist (CBCL) 1.5-5, assesses emotional and behavioral problems in children aged 1.5–5.²⁴⁾ The K-CBCL 1.5-5 summary profile includes 3 broadband scales: internalizing problems, externalizing problems, and total problems. A clinically significant *T* score is typically 64 or higher. To present participants' preintervention characteristics, *T* scores for summary scales were used and the raw values of each scale were analyzed for pre- and postintervention changes.

10. Mother-child interaction

Each mother-child dyad was video-recorded for 10 minutes while playing with designated toys in a controlled setting (the developmental clinic), both before and after the intervention. Mothers were encouraged to interact with their children naturally, reflecting their everyday routines. The selected toys were developmentally suitable for children and included a xylophone, picture books, picture cards, an imaginative play toy, a toy car, wooden puzzles, stacked rings, nesting blocks, and wooden dominoes. The video recordings served as the data source for assessing pre- and postintervention outcomes related to the following mother-child interaction.

1) Children's engagement: Korean-Children Behavior Rating Scale

We evaluated the pivotal behaviors of the children, using the said videotapes, based on the Korean version of the Child Behavior Rating Scale (K-CBRS).²⁵⁾ The K-CBRS comprises 7 global child engagement items: attention, persistence, interest, cooperation, initiation, joint attention,

and affect. These items were rated on a 5-point Likert scale, with ratings of 1 reflecting a low incidence of the quality being assessed, and 5 indicating a high incidence. The average of the 7 items was defined as the child's pivotal developmental behavior or the K-CBRS, while Cronbach's alpha and the Kaiser-Meyer-Olkin measure were 0.88 and .73, respectively.²⁵⁾

2) Mother's interaction style: Korean-Maternal Behavior Rating Scales

Videotaped observations of mother-child play were also used to assess the mother's interaction style. The Korean version of the Maternal Behavior Rating Scale (K-MBRS) was used to code the mother's interaction style.²⁵⁾ K-MBRS consists of 12 items, of which praise and pace were excluded from this study. These items were rated on a 5-point Likert scale, with ratings of 1 reflecting a low incidence of the quality being assessed, and 5 indicating a high incidence. The scores for the remaining 10 items were reduced to 3 subscales: responsive behavior (responsivity, sensitivity, acceptance, enjoyment, and warmth), effective behavior (effectiveness, expressiveness, and inventiveness), and directive behavior (achievement and directiveness). For the Korean MBRS,²⁵⁾ Cronbach alpha was 0.89, and the Kaiser-Meyer-Olkin measure was 0.86.

3) Interobserver agreement

Interobserver agreement was established by 2 independent raters who were blinded to the participants' information, including whether the video recording was pre- or postassessment. The raters had a master's degree in developmental psychology and had completed approximately 30 hours of training to attain an interrater agreement of 75% and 70% or more on the MBRS and CBRS scales, respectively. Disagreements across ratings were discussed, and a consensus was reached in all cases (Supplementary methods for details of interobserver agreement).

11. Assessment of acceptability

Acceptability of the online RT intervention was assessed using a self-developed posttest questionnaire, which included 8 multiple-choice questions using a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). A higher score on the scale indicates a greater level of acceptance. In cases where participants opted to express strong agreement or disagreement, they were given the opportunity to articulate their rationales in writing.

12. Statistics

The normality of the continuous variables was assessed using the Shapiro-Wilk test. Continuous variables were

expressed as means and standard deviations (if normally distributed) or as medians and interquartile ranges (if not normally distributed). Categorical variables were presented as frequencies (N) and percentages (%). Chi-square tests and Mann-Whitney *U* tests were performed to compare demographic characteristics between the groups. The Wilcoxon signed-rank test was used to compare the differences between the pre- and posttest outcomes for continuous variables.

Results

1. Participants characteristics

The mean chronological age of the 23 children was 2.66 ±0.86 years, whereas the mean developmental age was 1.66±0.50 years. Seventy-four percent of the children were from one-child families and the majority (87%) were male. The subtypes of diagnosis were language delay for 12 children (52%), ASD for 7 children (30.4%), and global delay for 4 children (17%). Regarding additional intervention services, 12 children (52%) received no other services, and the remaining (n=11, 48%) received institutional intervention. None of them had experience with parent-involvement interventions, including RT. All participating parents except one (96%) were mothers. All participating parents were married, with a mean age of 36.0±4.8 years.

Table 1. Subjects' demographic characteristics

Variable	Value
Children's characteristics	
Age (yr)	
Chronological age	2.6±0.9
Developmental age ^{a)}	1.7±0.5
Developmental quotient ^{b)}	67.0±12.0
Male sex	20 (87)
Presence of siblings	6 (26)
Subtype of diagnosis	
Language delay only	12 (52)
Global delay	4 (17)
Autism spectrum disorders	7 (30)
Clinically significant total behavioral problems ^{c)}	5 (22)
Mothers' characteristics	
Age (yr)	36.0±4.8
Education level	
≤High school	5 (22)
>High school	18 (78)
Marital status (% married)	23 (100)
Job status (% employed)	9 (39)
Clinically significant parenting stress ^{d)}	7 (30)

Values are presented as mean±standard deviation or number (%).

^{a)}Assessed using the Korean-Child Developmental Inventory. ^{b)}Calculated as developmental age/chronological age×100. ^{c)}Indicates *T* scores ≥64 on the total problem section of the Child Behavior Checklist. ^{d)}Indicates a percentile score ≥90 for total parenting stress on Parenting Stress Index-4 Short Form.

Most had a college degree or higher (83%), and 39% of the participating parents were employed. Table 1 summarizes the characteristics of the participants.

2. Changes in child outcomes

After the intervention, significant improvements were observed in various aspects of the children's behaviors (Table 2). A decrease in the total CBCL score indicated an improvement in the child's behavioral and

Table 2. Child scores pre- and postintervention

Variable	Pretest	Posttest	Difference between pre- and posttest	<i>P</i> value
CBCL				
Internalizing	11.0±7.1	10.3±6.5	0.7±0.7	0.33
Externalizing	13.4±8.2	11.9±7.3	1.5±0.8	0.07
Total score	40.3±21.6	36.3±20.7	4.0±2.1	0.04
CBRS				
Interest	2.6±0.7	2.8±0.7	-0.2±0.2	0.16
Attention	2.9±0.8	2.9±0.8	0.0±0.2	0.97
Persistence	2.4±0.6	2.4±0.6	0.0±0.1	1.00
Joint attention	1.8±0.9	2.3±0.9	-0.5±0.2	0.04
Affect	2.7±0.7	3.2±0.5	-0.4±0.2	0.01
Initiation	2.0±0.4	2.1±0.3	-0.1±0.1	0.31
Cooperation	2.1±1.0	2.6±0.7	-0.5±0.2	0.01

Values are presented as mean±standard deviation.

CBCL, Child Behavior Checklist; CBRS, Child Behavior Rating Scale. Boldface indicates a statistically significant difference with *P*<0.05.

Table 3. Parent scores pre- and postintervention

Variable	Pretest	Posttest	Difference between pre- and posttest	<i>P</i> value
PSI-4 FS				
Parental distress	34.6±9.0	31.4±8.4	3.2±1.7	0.17
Parent-child dysfunctional interaction	29.0±9.0	25.3±7.0	3.7±1.0	<0.01
Difficult child	29.0±7.0	27.4±6.8	1.7±1.0	0.07
Total score	92.6±20.8	83.7±19.4	8.8±2.8	0.01
MBRS				
Responsive behaviors	2.7±0.4	3.1±0.3	0.5±0.4	<0.01
Responsivity	2.8±0.6	3.1±0.4	0.3±0.6	0.06
Sensitivity	2.3±0.4	3.1±0.4	0.8±0.7	<0.01
Acceptance	2.7±0.5	3.0±0.5	0.3±0.8	0.11
Enjoyment	2.7±0.6	3.2±0.5	0.5±0.7	0.01
Warmth	3.1±0.5	3.5±0.5	0.4±0.8	0.04
Effective behaviors	2.4±0.5	3.2±2.6	0.2±0.6	0.06
Effectiveness	2.0±0.8	2.7±0.7	0.7±0.8	<0.01
Expressiveness	3.0±0.6	3.0±0.6	0.0±1.0	1.00
Inventiveness	2.2±0.6	2.4±0.5	0.2±0.6	0.18
Directive behaviors	3.4±0.7	3.5±2.2	-1.2±0.8	<0.01
Achievement	3.1±0.8	2.0±0.6	-1.1±0.9	<0.01
Directiveness	3.7±0.6	2.3±0.9	-1.3±1.0	<0.01

Values are presented as mean±standard deviation.

MBRS, Maternal Behavior Rating Scales; PSI-4 FS, Parent Stress Index-4 Short Form.

Boldface indicates a statistically significant difference with *P*<0.05.

emotional functioning ($P=0.04$). The K-CBRS analysis also demonstrated a positive impact on behaviors related to social-emotional and language development such as affect ($P=0.01$), joint attention ($P=0.04$), and cooperation ($P=0.01$). However, no significant changes were found in interest, attention, persistence, and initiative, following the intervention.

3. Changes in parent outcomes

After the intervention, significant improvements in parenting stress and interactive behavior were observed (Table 3). There was a significant reduction in total parenting stress ($P=0.01$), and parent-child dysfunctional interactions exhibited a significant decrease among the subfactors analyzed. K-MBRS analysis revealed a significant increase in responsive behaviors ($P<0.01$) and a decrease in directive behaviors ($P<0.01$). Specifically, improvements were exhibited in sensitivity ($P<0.01$), enjoyment ($P=0.01$), and warmth ($P=0.04$) among the responsive behaviors. Both the directive behaviors, achievement ($P<0.01$), and directiveness ($P<0.01$) significantly decreased.

4. Acceptability

In the acceptability questionnaire, the responses of almost all 23 participants indicated 'strong agreement' or 'agreement' concerning items related to the online format, content, outcomes, and feedback of the RT intervention, signifying a high level of satisfaction (mean scores ≥ 4.5), with only 2 exceptions (Table 4). The lowest satisfaction rating, with a mean score of 4.0 was linked to the adequacy of the number of RT sessions primarily because of the participants' perception of session insufficiency and their expressed desire for more sessions. The next lowest-rated item assessed willingness to continue applying the learned strategies, with a mean score of 4.4 points.

This pilot study assessed a 5-session online RT intervention's impact on parents of children with developmental disabilities during the COVID-19 pandemic. The results demonstrated positive changes in child and parent outcomes, including significant improvements in children's pivotal behaviors (affect, joint attention, cooperation), reduced problem behaviors, enhanced maternal responsiveness, and decreased parenting stress. Furthermore, the data suggest that online RT intervention was feasible, with a high recruitment rate (85.7%) and completion rate (90%). Parents expressed high satisfaction with the online program's delivery, content, and outcomes. In summary, these findings offer initial evidence supporting the effectiveness and acceptability of online RT interventions for parents of children with developmental disabilities.

As RT is an intervention that fosters child development through maternal behavior, the primary step was to examine changes in maternal interactive behavior resulting from the current intervention. Our study found that online RT positively affected mothers' overall interaction behavior, increasing responsive behavior and decreasing directive behavior. Our findings are largely consistent with those of previous in-person RT studies.^{18,26,27} Positive changes in responsive behaviors have been consistently reported across studies.^{18,26,27} Changes observed in directive behaviors varied between studies. For example, Mahoney and Perales,²⁷ with 33 intervention sessions on 50 American mother-child pairs with developmental disabilities over 1 year, reported no significant changes in directive behaviors. However, studies in Turkey (weekly for 6 months)¹⁸ and Korea (13 sessions),²⁶ showed a significant decrease. These variations may be attributed to differences in the characteristics of the participating mothers rather than the intensity of the intervention or the type of delivery. Mothers with higher preintervention directiveness, as seen in Korean²⁶ and Turkish¹⁸ studies, may become more sensitively aware of

Discussion

Table 4. Acceptability questionnaire results

Questionnaire	Strong agree (5) ^a	Somewhat agree (4)	Neutral (3)	Somewhat disagree (2)	Strongly disagree (1)	Mean \pm SD ^b
I am satisfied with the online delivery of the RT intervention.	17 (73.9)	6 (26.1)	0 (0)	0 (0)	0 (0)	4.8 \pm 0.4
The RT intervention was easy to understand.	18 (78.3)	5 (21.7)	0 (0)	0 (0)	0 (0)	4.8 \pm 0.4
The RT intervention session was appropriate.	8 (34.8)	9 (39.1)	4 (17.4)	2 (8.7)	0 (0)	4.0 \pm 0.9
I felt confident in interacting with my child after participating in the study.	13 (56.5)	10 (43.5)	0 (0)	0 (0)	0 (0)	4.6 \pm 0.5
My child has likely benefited from participating in this study.	18 (78.3)	5 (21.7)	0 (0)	0 (0)	0 (0)	4.8 \pm 0.4
I would recommend this type of intervention to others.	15 (65.2)	8 (34.8)	0 (0)	0 (0)	0 (0)	4.7 \pm 0.5
I would continue RT intervention with more sessions if available.	15 (65.2)	8 (34.8)	0 (0)	0 (0)	0 (0)	4.7 \pm 0.5
I will continue to interact with my child what I've learned from the online RT.	12 (52.2)	10 (43.5)	1 (4.3)	0 (0)	0 (0)	4.4 \pm 0.6

RT, responsive teaching; SD, standard deviation.

^a5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). ^bMean Likert-type scale score converted into scores from 1 (strongly disagree) to 5 (strongly agree).

their behavior through RT intervention.

The main goal of RT intervention is to enhance children's development by improving their pivotal behaviors.²⁰⁾ We observed improvements in joint attention, affect, and cooperation after the intervention. However, without a control group, we cannot definitively conclude the specific effectiveness of online RT on these pivotal behaviors. Nevertheless, it is worth noting that joint attention, a crucial developmental behavior for communication and social understanding,²⁸⁾ improved with only 5 sessions of online intervention. However, there were no significant changes in cognitive-related pivotal behaviors, such as Initiation and Attention. Our results were consistent with a previous in-person RT intervention conducted weekly for 3 months,¹⁶⁾ which showed improvements in parental interactive behaviors across all areas, but only limited changes in the child's pivotal behaviors. In contrast, high-intensity in-person RT interventions conducted weekly for 6 months to one year reported improvements in all pivotal behaviors, even when compared to the control groups.^{18,27)} These findings support prior research emphasizing the importance of intervention intensity in parenting training for child development, which typically shows higher effectiveness after >20 sessions.²⁹⁾ Further research on the efficacy of high-intensity online RT interventions is warranted to advance our understanding of this area.

This study also provides evidence that online RT interventions effectively reduce problematic behaviors and parenting stress. Our study's results are consistent with prior research on parenting behaviors and children's problem behaviors.³⁰⁻³³⁾ Existing literature suggests that directive or authoritative parenting increases problem behaviors, while warm and responsive approaches decrease them.³⁰⁻³³⁾ Following our online RT intervention, we observed increased responsive parenting and decreased directiveness. These changes may have not only impacted the child's pivotal behaviors but also contributed to a reduction in behaviors considered problematic overall. Among the 3 dimensions of parenting stress, a notable improvement was found in stress related to parent-child dysfunctional interaction, which means that parents perceived parent-child interactions as less stressful after the online RT sessions. However, the impact of RT on parenting stress varied across studies. RT's nature of parents learning and the application of the intervention may introduce additional stress to parenting. One study involving a 1-year RT intervention with 40% ASD children exhibited no change in parenting stress.²⁷⁾ In contrast, another study with 18% ASD children,²⁶⁾ employing a 3-month RT intervention, noted reduced overall parenting stress. In our study, 30% of the children had ASD. These results suggest the potential for varied effects of RT on parenting stress, depending on

the child's disability type, warranting further research in this area.

Parent feedback indicated a high acceptability of the online RT intervention, with participants displaying an overall optimistic attitude towards items in the acceptability questionnaire, including online delivery, content, and outcomes. However, the item assessing the adequacy of the number of RT sessions received the lowest score, suggesting that the number of intervention sessions was insufficient and needed to be increased. This discontent aligns with the earlier discussion that a more intensive intervention may be necessary to induce significant changes in children's behavior.²⁹⁾ Furthermore, this corresponds to the fact that nearly all participants expressed a willingness to participate in additional sessions, if available. The subsequent item displaying lower satisfaction pertained to the assessment of participants' willingness to continue applying the learned strategies. This could be because participants found the strategies helpful but also somewhat burdensome to incorporate into their daily routines. Parent feedback highlights 2 essential implications for future course optimization: the necessity of longer durations and booster training, as well as the need for additional support to address the stress and psychological burden experienced by parents.

The present study has several limitations. First, the absence of a control group and small patient sample size are methodological limitations that hinder the definitive interpretation of our findings. Second, the intervention period lasted 2–3 months, and no long-term follow-up data were collected; therefore, we could not evaluate the maintenance effects. Third, RT aims to enhance developmental outcomes. However, our study did not assess this because of the limited scope of a brief, short-term intervention, and our study consequently does not provide evidence that online RT can enhance developmental outcomes. The similarity in behavioral changes observed between parents and children in our study, as well as in prior long-term intervention data with positive developmental improvements,²⁷⁾ suggests the potential for positive developmental outcomes through online RT. However, it has been emphasized that implementing RT for at least 6 months is important for promoting positive changes in child development.¹⁴⁾ Therefore, for future studies, it is recommended to conduct randomized controlled trials with large sample sizes and long-term interventions to assess the effectiveness of the online RT program in enhancing child development. Fourth, the online RT used in the present study lacked a key component of the original in-person RT in which therapists demonstrated RT strategies to children. Consequently, affirming the complete equivalence of our intervention model to the original version is challenging.

Finally, the acceptability questionnaires used in the study were not verified. Detailed information related to online delivery (e.g., fidelity, facilitators, and barriers), burden of intervention, and suggestions for improvement were not included in the questionnaire.

In conclusion, our study demonstrates the effectiveness of a 5-session online RT program for parents with diverse developmental disabilities in Korea, especially amid the challenges of the COVID-19 pandemic. This program has the potential to enhance children's emotional and behavioral outcomes, improve maternal interaction behaviors, and reduce parenting stress levels. Considering the scarcity of early intervention services for young children, prolonged wait times for rehabilitation services, and the risk of future pandemics, online RT has emerged as a promising option for enhancing intervention accessibility and promoting improved health outcomes for children with developmental disabilities and their parents.

Footnotes

Supplementary material: Supplementary Table 1 and Supplementary methods can be found via <https://doi.org/10.3345/cep.2023.01662>.

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