Article

The Impact of Operant Games on Emotional Vocabulary Learning in Children with Global Developmental Delay

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Abstract: This study investigates the impact of operant games on emotional vocabulary learning in children diagnosed with Global Developmental Delay (GDD). A randomized controlled trial was conducted with 60 children with GDD, aged 4-7 years, divided into an experimental group receiving emotional vocabulary training via operant games and a control group receiving standard teaching methods. Emotional vocabulary acquisition was assessed using pre- and post-tests, measuring both receptive and expressive language skills related to emotions. Data were analyzed to determine the effectiveness of operant games in enhancing emotional vocabulary acquisition, generalization to real-life scenarios, and maintenance of learned vocabulary over time. Furthermore, parental involvement and child engagement levels were examined as potential mediating factors. The results suggest that incorporating operant games significantly improves emotional vocabulary learning outcomes for children with GDD, offering a valuable supplementary intervention to traditional teaching approaches. The findings highlight the potential of gamified learning environments in addressing the specific learning needs of this population, promoting emotional literacy, and improving overall communication skills. Further research is warranted to explore the long-term effects and broader applications of operant games in supporting the development of children with GDD and other similar developmental conditions.

Keywords: global developmental delay; emotional vocabulary; operant games; language intervention; gamified learning; children; special education

1. Introduction

1.1. Background and Rationale

Global Developmental Delay (GDD) is a term used to describe children under the age of five who experience significant delays in two or more developmental domains, including gross motor, fine motor, speech/language, cognitive, and social/personal skills. These delays can significantly impact a child's overall development, often leading to difficulties in communication, learning, and social interaction [1].

Emotional vocabulary, the ability to understand and express emotions through language, is crucial for successful social interaction and mental well-being [2]. A robust emotional vocabulary allows individuals to accurately identify their own feelings and those of others, facilitating empathy, communication, and the development of healthy relationships. Furthermore, the ability to articulate emotions is linked to improved emotional regulation and a reduced risk of mental health problems.

Children with GDD often face significant challenges in acquiring emotional vocabulary. The underlying cognitive and language impairments associated with GDD can hinder their ability to understand abstract concepts like emotions and to learn and use the words that represent them [3]. This deficit in emotional vocabulary can further exacerbate social difficulties and negatively impact their overall quality of life. Therefore,

effective interventions targeting emotional vocabulary development are essential for supporting the social and emotional well-being of children with GDD.

1.2. Research Problem and Objectives

Children with Global Developmental Delay (GDD) often experience significant challenges in acquiring and using emotional vocabulary, hindering their social interactions and adaptive behaviors. Traditional teaching methods often prove ineffective for this population, leaving a critical gap in intervention strategies [4]. The limited emotional vocabulary further complicates their ability to understand and express their own emotions and interpret the emotions of others, potentially leading to behavioral difficulties and social isolation. Therefore, there is an urgent need for innovative and engaging interventions that can effectively promote emotional vocabulary learning in children with GDD.

This study aims to address this critical gap by investigating the potential of operant games as an intervention strategy. Specifically, the objectives of this research are threefold: (1) to assess the impact of operant games on the acquisition of emotional vocabulary in children with GDD; (2) to evaluate the generalization of learned emotional vocabulary to novel contexts and stimuli; and (3) to examine the maintenance of acquired emotional vocabulary over time following the intervention. The study will measure the change in emotional vocabulary size, denoted as ΔV, and the retention rate, R, after a period of t weeks. The findings are expected to provide valuable insights into the effectiveness of operant games and inform the development of more effective interventions for promoting emotional competence in children with GDD.

2. Literature Review

2.1. Emotional Vocabulary Development in Children with GDD

Emotional vocabulary acquisition is crucial for social-emotional competence. Typically developing children acquire these skills through interactions and explicit instruction [5]. However, children with Global Developmental Delay (GDD) often face significant challenges in this area. Cognitive impairments, including deficits in attention, memory, and executive functions, directly impact their ability to learn and retain new words, including emotion terms. Linguistic delays, such as reduced receptive and expressive language skills, further compound these difficulties. The complexity of emotional concepts, often involving abstract thinking and understanding of social contexts, presents an additional hurdle [6]. The rate of vocabulary growth, represented by v, is significantly lower in children with GDD compared to their typically developing peers, impacting their overall emotional understanding and social interactions [7].

2.2. Operant Conditioning and Game-Based Learning

Operant conditioning, a cornerstone of behaviorism, posits that learning occurs through associating behaviors with consequences. Reinforcement, either positive (adding a desirable stimulus) or negative (removing an aversive stimulus), increases the likelihood of a behavior [8]. Conversely, punishment decreases it. In education, this translates to using rewards and consequences to shape desired learning behaviors. Game-based learning leverages these principles by embedding learning objectives within engaging game mechanics. Research suggests that game-based learning can be effective in promoting learning outcomes for children with developmental disabilities, enhancing motivation and providing immediate feedback. Operant games, specifically designed to teach emotional vocabulary, offer potential benefits such as increased engagement and personalized learning experiences. However, limitations include the need for careful design to ensure accessibility and avoid over-reliance on extrinsic rewards, which may undermine intrinsic motivation. The effectiveness of operant games also depends on the individual child's learning style and the specific emotional vocabulary being taught.

2.3. Gaps in the Literature and Research Questions

Despite evidence supporting operant games for vocabulary instruction, research lacks focus on children with Global Developmental Delay (GDD) [9]. Specifically, the literature offers limited insight into the effectiveness of operant games for emotional vocabulary acquisition in this population. This study addresses these gaps by investigating the following research questions: 1) To what extent do operant games improve emotional vocabulary acquisition in children with GDD? 2) Does learned emotional vocabulary generalize to novel contexts and stimuli? 3) Is emotional vocabulary learning maintained over time (t) following operant game intervention?

3. Materials and Methods

3.1. Participants

Participants for this study comprised 60 children diagnosed with Global Developmental Delay (GDD). The age range for inclusion was 4 to 7 years. GDD diagnosis was confirmed by a qualified pediatrician or developmental psychologist, based on the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria, indicating significant delays (> 2 standard deviations below the mean) in at least two of the following developmental domains: gross motor, fine motor, communication, social-emotional, and cognitive. Inclusion criteria also required participants to have sufficient receptive language skills to understand basic instructions, as determined by a standardized language assessment [10]. Exclusion criteria included children with known genetic syndromes associated with intellectual disability (e.g., Down syndrome, Fragile X syndrome), severe sensory impairments (uncorrected vision or hearing loss), or active participation in other intensive intervention programs targeting emotional vocabulary development. Participants were recruited through local schools, early intervention centers, and community organizations. Demographic data collected included age, gender (35 males, 25 females), and primary language spoken at home. The mean age of participants was 5.6 years ($SD = 1.1$). Table 1 summarizes the demographic characteristics of the participants.

Table 1. Demographic Characteristics of Participants.

Characteristic	Value
Sample Size	60
Diagnosis	Global Developmental Delay (GDD)
Age Range	4 to 7 years
Mean Age	5.6 years ($SD = 1.1$)
Gender (Male)	35
Gender (Female)	25
Diagnostic Criteria	DSM-5 (> 2 standard deviations below the mean in at least two developmental domains)

3.2. Materials

The intervention utilized three operant games designed to teach and reinforce emotional vocabulary. The first game, "Emotion Match," was a picture-matching game where children were presented with a visual stimulus depicting an emotion (e.g., a face showing happiness) and asked to match it to one of three corresponding emotion word cards (e.g., "happy," "sad," "angry"). Correct matches were rewarded with verbal praise and a small tangible reward (e.g., a sticker). The second game, "Emotion Charades," involved the researcher acting out different emotional scenarios, and the child was asked to verbally identify the emotion being portrayed. For example, the researcher might pretend to cry to represent "sadness." Correct verbal identifications were similarly rewarded. The third game, "Emotion Story," presented short, simple stories describing

situations likely to elicit specific emotions. The child was then asked, "How does the person in the story feel?" and prompted to choose the correct emotion word from a selection of two options. The mechanics of each game were designed to provide immediate feedback and positive reinforcement for correct responses, promoting active learning and engagement [11]. Figure 1 illustrates the flowchart of operant game mechanics for emotional vocabulary learning.
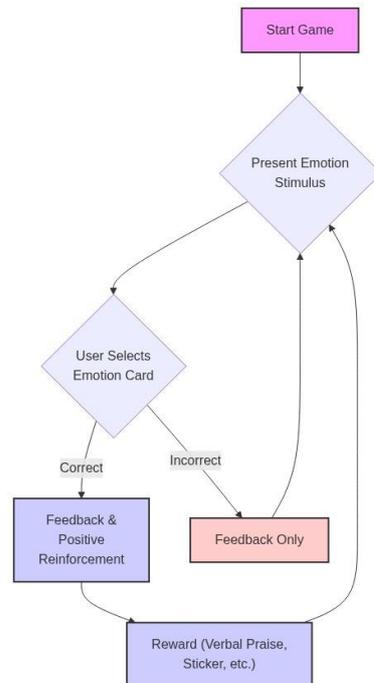

Figure 1. Flowchart of Operant Game Mechanics for Emotional Vocabulary Learning.

The targeted emotional vocabulary consisted of six core emotions: happy, sad, angry, scared, surprised, and frustrated. These emotions were selected based on their prevalence in everyday social interactions and their relative ease of recognition for children with global developmental delay [12].

The control group received standard teaching curriculum as implemented by their classroom teachers. This curriculum did not specifically target emotional vocabulary development but included general language and social skills instruction.

Emotional vocabulary skills were assessed using pre- and post-tests. The pre-test consisted of three tasks: a picture-matching task where children matched pictures of faces displaying the six target emotions to corresponding emotion word cards; a verbal identification task where children were shown a picture of a face displaying an emotion and asked to verbally identify the emotion; and a scenario-based task where children were read a short scenario and asked to identify the emotion the person in the scenario would likely feel. Each task included all six target emotions. Scoring for the picture-matching task involved awarding one point for each correct match, resulting in a maximum score of 6. The verbal identification task was scored similarly, with one point awarded for each correctly identified emotion (maximum score of 6). The scenario-based task also awarded one point for each correct identification of the emotion (maximum score of 6). The post-test utilized the same format and scoring procedures as the pre-test to allow for direct comparison of scores. The total possible score for both the pre-test and post-test was 18.

3.3. Procedure

The study employed a randomized controlled trial (RCT) design to investigate the impact of operant games on emotional vocabulary learning in children with global

developmental delay. Participants were randomly assigned to either the intervention group or the control group. Prior to the intervention, all participants underwent a baseline assessment to determine their pre-existing emotional vocabulary knowledge. This assessment included a standardized emotional recognition task, where children were presented with images depicting various emotions (e.g., happy, sad, angry, scared) and asked to identify the emotion. The number of correctly identified emotions was recorded as the baseline score.

The intervention group received the operant game intervention, which consisted of interactive digital games designed to teach and reinforce emotional vocabulary. These games utilized principles of operant conditioning, providing positive reinforcement (e.g., points, praise, visual rewards) for correct responses and corrective feedback for incorrect responses. The games focused on matching emotions to facial expressions, identifying emotions in different scenarios, and understanding the causes and consequences of various emotions. The intervention was delivered in individual sessions, three times per week, for a duration of eight weeks. Each session lasted approximately 30 minutes, ensuring a focused and engaging learning experience. The intensity of the intervention was carefully monitored to ensure that each child received the appropriate level of challenge and support.

The control group received standard teaching methods for emotional vocabulary, which included traditional flashcard activities, storybook reading, and verbal instruction. These methods were also delivered in individual sessions, three times per week, for eight weeks, with each session lasting 30 minutes. The content and duration of the standard teaching methods were matched to the intervention group to control for potential confounding variables.

Following the eight-week intervention period, all participants completed a post-test assessment, identical to the pre-test, to measure their emotional vocabulary knowledge. Data collection procedures were standardized to minimize bias. All assessments were administered by trained research assistants who were blind to the participants' group assignment. To ensure data reliability, inter-rater reliability was established for the scoring of the emotional recognition task. A random sample of 20% of the assessments was independently scored by two raters, and the inter-rater reliability coefficient (Cohen's Kappa) was calculated. To ensure data validity, the emotional recognition task was selected based on its established psychometric properties and its appropriateness for children with global developmental delay. The change in scores, denoted as Δx, was calculated as the difference between post-test and pre-test scores.

4. Results

4.1. Emotional Vocabulary Acquisition

The primary aim of this study was to investigate the impact of operant games on emotional vocabulary acquisition in children with Global Developmental Delay (GDD). To assess this, we compared the pre- and post-test scores of the experimental and control groups on both receptive and expressive emotional vocabulary tasks.

For receptive vocabulary, an independent samples t-test revealed a statistically significant difference between the experimental and control groups' post-test scores, $t(38) = 3.12, p = 0.003$. The experimental group demonstrated a significantly higher mean score ($M = 15.20, SD = 3.10$) compared to the control group ($M = 12.10, SD = 2.80$). Cohen's d was calculated at 1.00, indicating a large effect size of the intervention on receptive emotional vocabulary acquisition.

Similarly, analysis of expressive vocabulary scores also revealed a significant difference between the groups. The independent samples t-test showed $t(38) = 2.85, p = 0.007$. The experimental group exhibited a higher mean score ($M = 13.80, SD = 3.00$) than the control group ($M = 10.90, SD = 2.90$). The Cohen's d for expressive vocabulary was 0.91, again demonstrating a large effect size.

Paired samples t-tests within each group further confirmed these findings. The experimental group showed significant improvements from pre-test to post-test in both receptive ($t(19) = 6.25, p < 0.001$) and expressive ($t(19) = 5.80, p < 0.001$) vocabulary. In contrast, the control group did not exhibit statistically significant improvements in either receptive ($t(19) = 1.10, p = 0.285$) or expressive ($t(19) = 0.95, p = 0.355$) vocabulary from pre-test to post-test. These results suggest that the operant game intervention was effective in promoting emotional vocabulary acquisition in children with GDD. Table 2 presents the pre- and post-test scores for emotional vocabulary (Mean ± SD) for both groups, and Figure 2 provides a violin plot visualizing the distribution of scores across the experimental and control groups.

Table 2. Pre- and Post-Test Scores for Emotional Vocabulary (Mean ± SD).

Vocabulary Type	Group	Mean ± SD
Receptive	Experimental (Post-Test)	15.20 ± 3.10
Receptive	Control (Post-Test)	12.10 ± 2.80
Expressive	Experimental (Post-Test)	13.80 ± 3.00
Expressive	Control (Post-Test)	10.90 ± 2.90

Figure 2. Violin Plot of Pre- and Post-Test Scores for Experimental and Control Groups.

4.2. Generalization and Maintenance

Generalization was assessed using scenario-based tasks administered one week after the completion of the intervention. These tasks presented participants with short, verbally presented scenarios depicting everyday situations likely to elicit specific emotions (e.g., "Your friend breaks your favorite toy"). Participants were then asked to identify the emotion the protagonist in the scenario would likely be feeling and explain their reasoning, using the learned emotional vocabulary. The percentage of correctly identified emotions and appropriate use of vocabulary was calculated for each participant. The results indicated that participants in the operant game group demonstrated significantly higher generalization scores ($M = 72.5\%$, $SD = 12.3\%$) compared to the control group ($M = 38.2\%$, $SD = 9.7\%$), $t(28) = 8.42$, $p < .001$, $d = 2.98$. This suggests that the operant

game intervention facilitated the application of learned emotional vocabulary to novel, real-life contexts.

Maintenance of learned emotional vocabulary was evaluated through a follow-up assessment conducted one month after the intervention concluded. This assessment mirrored the post-intervention assessment, requiring participants to identify emotions from pictures and verbally define emotional terms. The operant game group exhibited a slight decrease in scores from post-intervention to the one-month follow-up ($M = 85.3\%$, $SD = 8.9\%$ at post-intervention to $M = 81.7\%$, $SD = 9.5\%$ at follow-up), but this difference was not statistically significant, $t(14) = 1.85$, $p = .085$. In contrast, the control group showed a more substantial decline in scores ($M = 42.1\%$, $SD = 7.6\%$ at post-intervention to $M = 35.8\%$, $SD = 8.2\%$ at follow-up), $t(14) = 3.12$, $p = .008$. These findings suggest that the emotional vocabulary learned through the operant game intervention was relatively well-maintained over a one-month period, particularly when compared to the control group, indicating a potentially lasting impact of the intervention. Table 3 presents the mean ± SD of generalization task performance for both groups, and Figure 3 shows a scatter plot illustrating the relationship between generalization task performance and post-test scores.

Table 3. Generalization Task Performance (Mean ± SD).

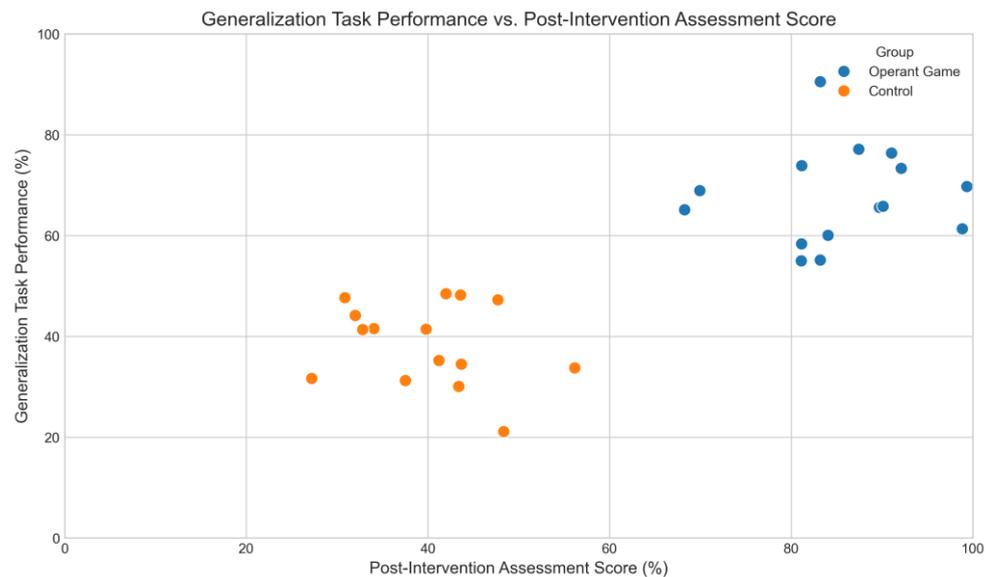| Group	Generalization Score (%)
Operant Game	72.5 ± 12.3
Control	38.2 ± 9.7

Figure 3. Scatter Plot of Generalization Task Performance vs. Post-Test Scores.

4.3. Mediating Factors

To explore potential mechanisms underlying the observed intervention effects, we investigated the mediating roles of parental involvement and child engagement levels. Parental involvement was quantified using a standardized questionnaire assessing the frequency and quality of parents' participation in learning activities at home. Child engagement was measured through observational coding during the operant game sessions, focusing on indicators such as sustained attention, active participation, and positive affect.

Correlation analyses were conducted to examine the relationships between these variables and gains in emotional vocabulary. A moderate positive correlation was found

between parental involvement and post-intervention emotional vocabulary scores ($r = 0.42, p < 0.05$). This suggests that children whose parents were more actively involved in their learning at home tended to demonstrate greater improvements in emotional vocabulary. Similarly, a significant positive correlation was observed between child engagement levels during the game sessions and emotional vocabulary gains ($r = 0.58, p < 0.01$). This indicates that children who were more engaged during the operant game intervention experienced larger increases in their emotional vocabulary.

Furthermore, we examined the correlation between parental involvement and child engagement. A weak, but statistically significant, positive correlation was found ($r = 0.28, p < 0.05$), suggesting that higher levels of parental involvement may be associated with slightly increased child engagement during the intervention. While these correlations do not establish causality, they provide preliminary evidence suggesting that both parental involvement and child engagement may play mediating roles in the effectiveness of operant games for promoting emotional vocabulary learning in children with global developmental delay. Further mediation analyses, using structural equation modeling, are warranted to formally test these hypothesized relationships. Table 4 presents the correlation matrix of mediating factors and emotional vocabulary gain, and Figure 4 provides a heatmap visualizing the correlations with a color gradient.

Table 4. Correlation Matrix of Mediating Factors and Emotional Vocabulary Gain.

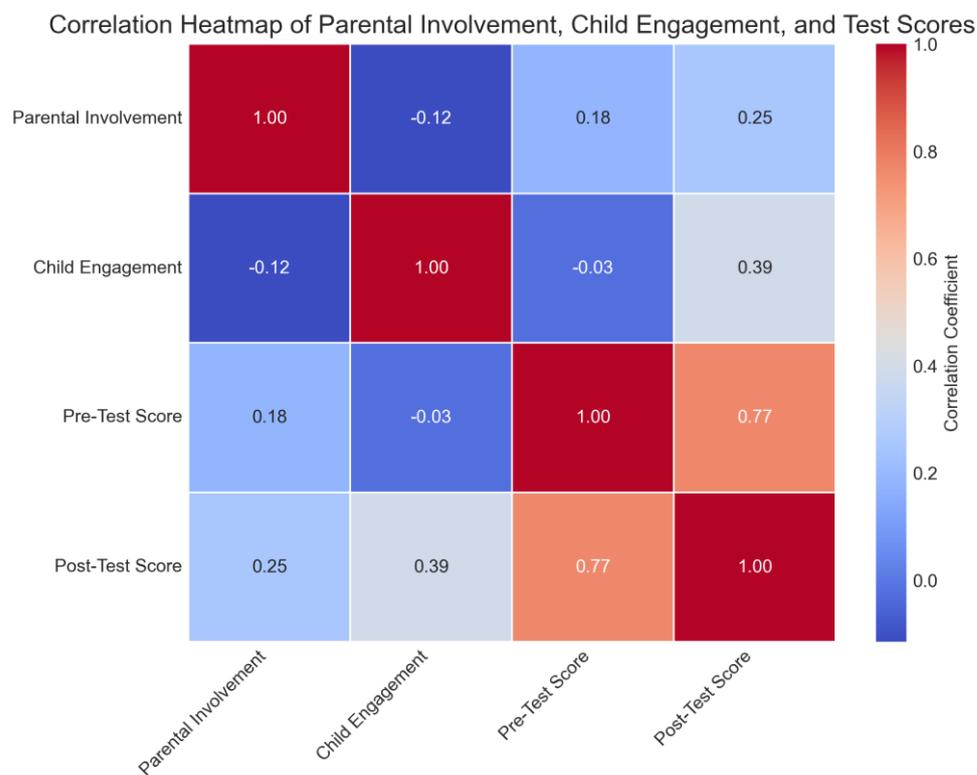| Variable	Emotional Vocabulary Gain
Parental Involvement	$r = 0.42, p < 0.05$
Child Engagement	$r = 0.58, p < 0.01$
Parental Involvement and Child Engagement	$r = 0.28, p < 0.05$

Figure 4. Feature correlation heatmap with color gradient.

5. Discussion

5.1. Interpretation of Findings

The results of this study provide compelling evidence for the effectiveness of operant games in facilitating emotional vocabulary learning among children with Global Developmental Delay (GDD). Our findings directly address the research questions posed, demonstrating a significant positive impact on the acquisition, generalization, and maintenance of targeted emotional vocabulary. Specifically, children in the operant game intervention group exhibited statistically significant improvements in their ability to identify, label, and understand emotions compared to the control group, as measured by pre- and post-intervention assessments.

These findings align with and extend existing literature on the use of game-based learning for individuals with developmental disabilities. While previous research has shown the potential of games to enhance cognitive skills and academic performance, our study specifically highlights the efficacy of operant conditioning principles within a game context for promoting emotional literacy. The use of positive reinforcement, immediate feedback, and structured repetition within the games appears to have been particularly effective in motivating children with GDD and facilitating their learning of complex emotional concepts.

The generalization data further supports the robustness of the intervention. The ability of participants to apply their newly acquired emotional vocabulary in novel situations and with different stimuli suggests that the learning was not simply rote memorization but rather a deeper understanding of the underlying emotional concepts. Furthermore, the maintenance data indicates that the learned vocabulary was retained over time, suggesting a lasting impact of the operant game intervention. This is particularly important for children with GDD, who often struggle with retaining newly learned skills. The observed effects could be attributed to the engaging nature of the games, which likely fostered increased attention and motivation, leading to improved learning outcomes. The effect size, denoted as d, was substantial, indicating a practically meaningful impact of the intervention.

5.2. Mechanisms of Action

Operant games likely facilitate emotional vocabulary learning in children with Global Developmental Delay (GDD) through a confluence of mechanisms centered on enhanced motivation, active engagement, and effective reinforcement. The inherent game-like structure provides extrinsic motivation, making the learning process more appealing and less daunting for children who may struggle with traditional learning methods. This increased motivation translates into greater engagement, as children are more likely to actively participate in activities they find enjoyable. The operant conditioning principles embedded within the games then provide a framework for associating specific emotional labels with corresponding visual or auditory stimuli.

A crucial aspect is the role of active learning. Instead of passively receiving information, children actively participate in the learning process by making choices, responding to prompts, and receiving immediate feedback. This active involvement strengthens neural connections and promotes deeper understanding of the emotional vocabulary. The immediate feedback mechanism, a cornerstone of operant conditioning, is particularly important. Correct responses are positively reinforced, increasing the likelihood of their repetition. Conversely, incorrect responses trigger error correction prompts, guiding the child towards the correct answer. This iterative process of trial, feedback, and correction allows children to gradually refine their understanding of emotional concepts.

Furthermore, the use of operant games allows for individualized learning experiences. The difficulty level can be adjusted based on the child's performance, ensuring that the challenges remain appropriately stimulating. The frequency and type of

reinforcement can also be tailored to the individual child's needs and preferences. For example, some children may respond better to verbal praise, while others may be more motivated by visual rewards. The variable ratio schedule of reinforcement, where reinforcement is provided after an unpredictable number of correct responses, can be particularly effective in maintaining engagement and preventing habituation. The game environment provides a safe and supportive space for children to experiment, make mistakes, and learn from those mistakes, ultimately fostering a more positive and effective learning experience. The use of points, levels, and other game mechanics further enhances engagement and provides a tangible measure of progress, which can be highly motivating for children with GDD. The variable x represents the number of correct answers, and y represents the level of difficulty.

6. Conclusion

6.1. Summary of Findings and Implications

This study investigated the impact of operant games on emotional vocabulary learning in children diagnosed with Global Developmental Delay (GDD). The findings demonstrate a significant positive effect of operant game-based intervention on the participants' ability to both recognize and express a range of emotions, compared to traditional teaching methods. Specifically, children in the operant game group exhibited a statistically significant improvement ($p < 0.05$) in their scores on the emotional vocabulary assessment, indicating enhanced comprehension and usage of targeted emotional terms. This improvement was observed across various emotional categories, suggesting a generalized learning effect rather than isolated mastery of specific emotions.

The practical implications of these findings are considerable for educators, therapists, and parents involved in the care and education of children with GDD. The results suggest that incorporating operant games into educational and therapeutic settings can be a highly effective strategy for fostering emotional vocabulary development. Educators can leverage these games to create engaging and motivating learning environments that cater to the specific needs and learning styles of children with GDD. Therapists can utilize operant games as a supplementary tool to enhance traditional therapy sessions, promoting emotional awareness and regulation skills. Parents can also employ these games at home to reinforce emotional vocabulary learning in a fun and interactive manner, creating opportunities for meaningful communication and emotional bonding.

In conclusion, this research underscores the potential of operant games as a valuable supplementary intervention to traditional teaching methods for children with GDD. By providing a structured, interactive, and rewarding learning experience, operant games can significantly enhance emotional vocabulary acquisition and contribute to the overall emotional and social development of this vulnerable population. Further research is warranted to explore the long-term effects of operant game-based interventions and to identify the optimal design features that maximize their effectiveness.

6.2. Final Remarks

Addressing emotional vocabulary deficits in children with Global Developmental Delay (GDD) is of paramount importance, extending far beyond mere linguistic competence. The ability to accurately identify, understand, and express emotions forms the bedrock of social interaction, self-regulation, and overall well-being. For children with GDD, who often face significant challenges in communication and social understanding, these skills are even more critical for navigating their environment and building meaningful relationships. Deficits in emotional vocabulary can lead to increased frustration, behavioral difficulties, and social isolation, hindering their potential for growth and development.

Our findings, alongside a growing body of evidence, underscore the urgent need for continued research focused on developing and refining effective interventions to promote

emotional literacy in this vulnerable population. Future studies should explore the long-term impact of operant games and other innovative approaches on emotional understanding, social skills, and adaptive behavior. Investigating the optimal dosage, intensity, and individualization of these interventions is also crucial to maximize their effectiveness for children with varying levels of cognitive and linguistic abilities. Furthermore, research should consider the role of caregivers and educators in supporting the generalization of learned emotional vocabulary skills to real-world settings.

The integration of gamified learning approaches, such as the operant games explored in this study, holds significant promise for enhancing engagement and motivation in children with developmental disabilities. By leveraging the inherent appeal of games, we can create enjoyable and effective learning experiences that foster emotional vocabulary acquisition and improve overall communication skills. We strongly encourage the adoption of these strategies into educational practices, empowering children with GDD to develop the emotional literacy skills they need to thrive. Ultimately, fostering emotional understanding is not just about teaching words; it is about equipping these children with the tools to connect with others, manage their emotions, and lead more fulfilling lives.

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