

Implementation of the Homeostasis-Enrichment-Plasticity (HEP®) Approach for an Infant at Risk for Autism Spectrum Disorder: A Case Report

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Implementation of the Homeostasis-Enrichment-Plasticity (HEP®) Approach for an Infant at Risk for Autism Spectrum Disorder: A Case Report

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Article Info	ABSTRACT
Received May 18, 2025 Accepted: July 01, 2025 Published: July 4, 2025 Keywords: Early intervention, Enriched environment Autism, Infant development.	Background and Clinical Significance: This case report explicates the implementation and outcomes of the Homeostasis-Enrichment-Plasticity (HEP®) Approach in a 10-month-old male infant with an increased risk of Autism Spectrum Disorder (ASD) who exhibited challenges in sensory functioning and motor development. Case Presentation: The intervention was carried out utilizing the eleven-step HEP® Approach process. The Peabody Developmental Motor Scale-2 (PDMS-2), Test of Sensory Function in Infants (TSFI), Adaptive Behavior Assessment System-3 (ABAS-3), and Goal Attainment Scale (GAS) were used as outcome measures before and after the intervention. A pediatric physical therapist conducted an hour-long intervention weekly for 10 weeks using the HEP® Approach implementation guide. Post-intervention, the infant's fine and gross motor skill scores in the PDMS-2 and General Adaptive Composite in the ABAS-3 exhibited significant improvement, as determined by the 95% confidence interval overlap analysis. The TSFI total score also improved categorically. An overall GAS score of +1.6 corresponded to a t-score of 74.12, indicating significant progress towards the individualized intervention goals. Conclusions: The HEP® Approach enhanced motor development, sensory functioning, general adaptive skills, and parental goals in a 10-month-old infant at risk for ASD. The results support further examination of the HEP approach's effectiveness in infants at risk for ASD.

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Introduction

The Autism spectrum disorder (ASD) is a diverse neurodevelopmental condition that manifests in early life, resulting from a complex interplay of genetic and environmental variables.^{1,2} Approximately 1 in 59 children are diagnosed with ASD across all racial, ethnic, and socioeconomic demographics, with prior studies indicating a consistent rise in ASD prevalence over the last two decades.³ The condition is associated with impaired social interaction and communication abilities, and individuals with ASD exhibit atypical repetitive behaviors and/or restricted interests.^{4,5} Motor deficits are both prevalent and extensive. Recent findings demonstrate that ASD is linked to increased clumsiness, motor coordination deficits, postural instability, and poor performance on standardized motor functioning assessments.⁶⁻⁹ Research indicates that early motor difficulties during the first two years of life may exacerbate the social impairments in children with ASD.⁹⁻¹⁴ Furthermore, early identification of motor signs in infants with ASD may facilitate a prompt autism diagnosis. Consequently, it is essential to monitor for potential motor signs within the first year of life, as these may manifest before the emergence of social communication deficits.¹⁵

Moreover, differences in sensory processing also constitute a significant characteristic of children with ASD. These differences can manifest as either hypo- or hyper-sensitivity, sensory perception and praxis deficits, and reduced or increased sensory exploration of the environment.^{14,16} In addition, disrupted sensory processing during infancy may contribute to the development of subsequent features, such as social-communication challenges. This suggests that sensory patterns may serve as essential behavioral indicators for early detection of ASD, thereby creating opportunities for early intervention that can result in improved outcomes.¹⁷⁻¹⁹

In addition to motor and sensory performance challenges, adaptive behavioral skills are also impacted in ASD.^{3,20,21} Lower scores in adaptive behavior, as measured by the adaptive behavior section of the Bayley®-III (reduced raw scores across the communication, community use, functional preacademics, home living, health and safety, leisure, self-care, self-direction, and social subscales), were identified as predictors of ASD in young children.³

Developmental assessments and behavioral observations are often used to determine diagnosis, with children usually receiving a diagnosis after age two²². Consequently, infants at risk of ASD must have developmental evaluations, particularly of sensory processing^{17,19}, motor development¹⁵, and adaptive behavioral skills³ within the first two years of life to facilitate early identification and support.

Evidence indicates that earlier and intensive intervention correlates with a higher probability of an enhanced developmental trajectory in ASD.^{3,23-25} Nonetheless, intensive early intervention programs have constraints regarding accessibility and implementation.²⁶⁻²⁹ Furthermore, although it is recommended that early intervention (EI) services cater to the needs of children across five developmental domains—cognitive, motor, social-emotional, communication, and adaptive development—current EI approaches are limited in their ability to address all these areas concurrently.³ Beyond this, EI is suggested to emphasize environmental enrichment (EE), which has beneficial effects across many developmental domains.³⁰⁻³³

Animal studies have extensively researched the beneficial consequences of EE on various domains, including behavior, learning, motor skills, mood, cognitive abilities, and brain structure and function.³³⁻³⁶ Moreover, studies have shown that EE significantly improves animal models of both idiopathic and syndromic autism.^{33,37,38} Although the number of studies showing the positive effects of EE-based early intervention approaches on infants with developmental risks is increasing^{32,39-43}, such intervention studies specifically with infants at risk for ASD are limited.^{4,33,44,45}

The Homeostasis-Enrichment-Plasticity (HEP®) Approach, a novel EI intervention model, was developed to address these limitations and apply the principles of enriched environment (EE) paradigms and ecological developmental theories to clinical physical and occupational therapy practices.^{31,32,39} The HEP® Approach, in contrast to existing models, thoroughly integrates the essential principles of EE paradigms and neural plasticity from experimental animal studies into ecological theories of human development while highlighting the critical significance of physiological homeostasis in the child and the child's relationship with the parents.³¹ This novel approach targets developmental areas such as homeostasis, sensory processing, social-

emotional functioning, motor abilities, problem-solving, planning, and functional performance.^{31,32,39} Additionally, most parents of infants with developmental risks have found the HEP® Approach intervention safe, feasible, and acceptable for implementation. Furthermore, the HEP® Approach is family-based and, by nature, provides a continuous and intensive therapeutic environment in the home and the clinic.³⁹

The current study postulated that a 10-month-old infant identified as being at risk for ASD and displaying sensory-motor developmental delays would benefit from use of the HEP® Approach in areas of motor development, sensory functioning, adaptive behavior, and goal attainment. In particular, it was anticipated that the HEP® Approach's structured and enhanced intervention environment would foster quantifiable advancements in many developmental domains. This case study was guided by the following research questions: (1) Is it feasible to apply the HEP® Approach with a baby at risk for ASD in compliance with its standardized implementation guide? (2) Does the HEP® Approach improve motor development, sensory functioning, adaptive behavior, and goal attainment? Observations made during the initial clinical intake and evaluation phase showed that the infant struggled with motor milestones (such as lack of crawling or assisted standing), typical sensorimotor responses (such as aversion to tummy time, decreased exploration), and social interaction (such as reduced joint attention or communicative interactions with caregivers). These early indicators justified the application of the HEP® Approach as a thorough and environmentally based early intervention model.

Case Presentation

Study Design

A descriptive case report-informed methodology was used to investigate the utilization of the HEP® Approach for an infant at risk for ASD and with sensory-motor developmental challenges. This case report was deemed exempt from ethics review given that all data collected was done as part of clinical practice and all personal information was de-identified. Furthermore, informed consent was obtained per Helsinki guidelines.

Participant

A was a 10-month-old male with a birth weight

of 3,320 grams. The mother was monitored for placenta previa during pregnancy, resulting in a cesarean section on the scheduled due date. Upon evaluation of the postpartum period, we found that A experienced hypoglycemia, a condition resulting from the mother's inadequate amount of milk, and had undergone circumcision due to hypospadias. The hospital discharged the family two days post-birth, following the necessary examinations. At one month of age, A's mother observed that he seldom gazed at his parents' faces and suspected that something was wrong. The pediatrician recommended that the family see a pediatric neurologist for a diagnostic assessment. A's suspicion of ASD commenced at six months of age, after a thorough neurological assessment. When A was 9 months old, his parents consulted another neurologist and child psychiatrist. All involved professionals determined that A was at risk of developing ASD and referred the family to a special education teacher for standard early intervention services. During the same period, A's family and the special education teacher requested an assessment from the first author (a physical therapist with a PhD doctoral degree, advanced training in sensory integration, and over 15 years of pediatric experience) due to the infant's delayed motor development and difficulties in sensory functions. A comprehensive developmental history and parent interview conducted by the second author revealed that A exhibited repetitive behaviors (i.e., hand flapping) in social settings, diminished facial expressions, experienced anxiety in external situations, and a lack of drive to engage in activities. The infant's family reported that A disliked tummy time, was unwilling to crawl, and was unable to stand with support.

The parents' primary concerns were A's delayed social-emotional abilities and motor development (i.e., delayed four-point crawling, standing with assistance, and positional transitions from lying to sitting or from sitting to standing). Additionally, they were concerned about the difficulties he had with his regulatory capacities and attention, particularly in unfamiliar situations.

Outcome Measures

Peabody Developmental Motor Scales – 2 (PDMS-2)

The PDMS-2 functions as an instrument for evaluating motor development. The assessment comprises six subtests that measure children's gross

and fine motor skills from infancy to five years. Every PDMS-2 subtest contributes to the computation of a Total Motor Quotient (TMQ). This score is generally considered the most precise evaluation of overall motor skills. Additionally, each subtest contributes uniquely to the Gross Motor Quotient (GMQ) or the Fine Motor Quotient (FMQ) score. The GMQ evaluates reflexes and the ability to engage the primary muscle systems for locomotion, sustain a stable posture while immobile, and perform object manipulation tasks. The FMQ evaluates a child's manual dexterity and ability to manipulate objects, grasp items, stack blocks, draw shapes, and coordinate visual and motor skills. The PDMS-2 is acknowledged as a reliable and valid instrument for assessing the motor development of infants at developmental risk. The PDMS-2 exhibits exceptional discriminative reliability, validity, and substantial test-retest reliability.^{46,47}

Test of Sensory Functions in Infants (TSFI)

The TSFI offers objective criteria for clinicians to assess the presence and degree of infant sensory functioning challenges. The TSFI is specifically intended for infants aged 4 to 18 months. The assessment comprises 24 items categorized into five sub-tests: reactivity to deep touch pressure, adaptive motor functions, visual-tactile integration, ocular-motor control, and reactivity to vestibular stimulation. In the 24-item TSFI, the evaluator interacts with the infant and introduces various stimulating inputs, documenting the child's responses according to explicit scoring standards. The normal distribution curve categorizes scores above -1 SD as "normal," scores ranging from -1 SD to -2 SD as "at-risk," and scores falling below -2 SD as "deficient."^{32,39,48}

Adaptive Behavior Assessment System Third Edition (ABAS-3)

The ABAS-3 is an essential assessment instrument for measuring adaptive behavior within the 0 - 89-year age spectrum. ABAS-3 consists of five assessment forms used to collect information about the adaptive behaviors of individuals in different environments. These forms are: Parent/Primary Caregiver Form (Ages 0-5), Parent Form (Ages 5-21), Teacher/Nursery Caregiver Form (Ages 2-5), Teacher Form (Ages 5-21), and Adult Form (Ages 16-89). These forms, which require sixth-grade reading ability, can be completed in 20 minutes. The form used in this study is the Parent/Primary Caregiver Form (Ages 0-5). The

form, which evaluates the adaptive functioning of infants and preschool children in home and other environments, can be completed by parents and other primary caregivers. It encompasses three overarching adaptive domains: conceptual, social, and practical. It evaluates 11 adaptive skill domains. The ABAS-3 encompasses distinct adaptive skill domains frequently recognized in definitions and assessments of adaptive behavior: communication, community use, functional academics, health and safety, home or school living, leisure, self-care, self-direction, social skills, motor and vocational skills. Items concentrate on essential daily tasks necessary for functioning, addressing environmental needs, self-care, and engaging with others autonomously and proficiently. Raters utilize a four-point response scale to assess whether the individual can execute each action and, if affirmative, the frequency of its performance as required. Scaled scores for adaptive skill domains are presented, with ten skill area scores aggregated to generate standard scores in the following categories: conceptual (communication, functional academics, and self-direction), social (social skills and leisure), and practical (self-care, home or school living, community use, health and safety, and adult employment). The General Adaptive Composite (GAC) encompasses all skill areas, including motor. Standard scores possess a mean of 100 and a standard deviation of 15; low scores indicate poorer competencies in these skill domains. All subscale scores were transformed into equivalent standard scores to ensure consistency with composite scores. A general adaptive composite standard score is created from the results in the adaptive skill areas. Reliability was examined through internal consistency, temporal stability, inter-rater reliability, and cross-form consistency. The Alpha reliability coefficient for all forms of ABAS-3 was found to be between 0.96-0.99, and the Alpha internal consistency coefficient for the 0-5 age parent/caregiver form was 0.94-0.99. These values reveal that it is a measurement tool with a high level of reliability.^{49,50}

Goal Attainment Scaling (GAS)

Goal Attainment Scales (GAS) were used to gather progress on individualized functional parent-established goals. GAS is the most recommended goal-setting methodology for measuring change during and after intervention in clinical and research applications. Evidence suggests that GAS is a reliable tool for children with developmental challenges.^{32,39} GAS provides subjective information

about the client's needs and measures the extent to which the intervention achieves the client's individualized goals set at the start of intervention. Generally, a 5-point scale (-2 to +2) is used to scale goals. Zero (0) is specified as the predicted level of performance, with -1 indicating somewhat less than expected outcome, -2 much less than expected outcome, +1 somewhat more than expected outcome, and +2 much more than expected outcome.⁵¹⁻⁵⁴ This study employed the goal scaling approach delineated by Kiresuk et al. (2014).

Intervention

The HEP® Approach intervention comprised weekly clinic-based parental coaching conducted by a physical therapist with over five years of pediatric expertise for a total of 10 one-hour sessions. The therapist underwent training and supervision in the HEP® Approach from the first author before commencing the study. The family submitted videos to their therapist weekly through the Whatsapp application and received comments to facilitate the home implementation of activities and recommendations discussed during clinical sessions. The clinic-based intervention videos were evaluated weekly, and the first author provided input to the treating therapist to ensure that the sessions adhered to the fidelity standards of the HEP® Approach.

The HEP® Approach employs the fundamental principles of enriched environment models and neural plasticity, commonly used in experimental animal studies. It contextualizes these principles within the framework of ecological theories of human development, emphasizing the crucial role of homeostasis in the developmental process.³¹ During the intervention, the therapist guides the family to provide continuous, individually tailored environmental conditions that encourage the child's active exploration and engagement. The HEP® Approach comprises ten essential intervention principles: physiological homeostasis, provision of sensory experiences, safety, environmental and object novelty, novelty of spatial features within the environment, the just-right challenge, enjoyment, social opportunities, continuous engagement with the environment, and active exploration of the environment (see ^{31,32,39} for details on the intervention). The HEP® Approach intervention process includes an 11-step data-driven decision-making framework similar to the method described by Schaaf & Mailloux (2015).⁵⁵ The initial four phases comprise referring the family to a HEP-

trained therapist along with the rationale for referral, interviewing the family, performing a comprehensive evaluation, and determining the family's and child's limitations and strengths based on the initial assessment. The fifth phase involves hypothesis formulation, the sixth phase encompasses collaborative goal-setting, the seventh phase pertains to outcome measure identification, the eighth phase focuses on intervention planning, the ninth phase is dedicated to intervention implementation, the tenth phase includes family home follow-up and monitoring, and the eleventh phase entails evaluation of intervention effectiveness (see Appendix for details).³⁹ The intervention follows the HEP® Approach guidelines established by Balikci et al. (2024b).



Figure 1. Sample Activity: The child is placed inside a small inner tube.

Figure 1 presents an example activity that exemplifies a proposed study activity following the HEP® Approach application guide.³⁹ A breakdown of how the suggested sample activity implements the ten HEP® Approach intervention components as described in the HEP® Approach implementation guide is described below.³⁹

1. Homeostasis: The family facilitates homeostasis by adhering to the therapist's advised positions (e.g., being at the level of the infant's eye), employing a soothing tone of voice, and being predictable.

2. Safety: The infant maneuvered his body more securely using the inner tube suggested by the therapist. Furthermore, the family's establishment of consistent routines enhanced the baby's sense of security. Parental presence when the infant requests guidance and safety reassurance enhances the child's sense of security.

3. Sensory Experiences: The activity in an

upright position enhances the baby's visual perception, facilitating active exploration and participation. Furthermore, the inner tube around the infant and the supportive relationship with the parent promotes the infant's mobility, offering a variety of sensory experiences.

4. Spatial: The spatial support and boundaries afforded to the infant by the inner tube enable the infant to explore movement opportunities in diverse and expansive contexts. Consequently, it allows the infant to investigate distant spaces and objects visually and manually. In addition, the supportive attitude of individuals surrounding the infant facilitates the child's active exploration and engagement.

5. Novelty: In this situation, the family provides novelty to the activity by encouraging the infant to move in various directions (e.g., go from sit to stand, move right or left). Additionally, the gestures or toys the parent employs provide additional novelty, which can motivate the child.

6. Challenge: Here, the parent presents the just-right challenge with changes to the environment and activities. For example, as the baby's ability to move within the inner tube improves, the parent can raise the tube to provide a somewhat higher level of challenge that the baby can manage.

7. Enjoyment: To promote the infant's enjoyment and engagement, preferred objects, toys, or games are incorporated into the activity. For instance, if the baby enjoys it, the "peekaboo" game would be beneficial to integrate into the activity.

8. Continuous Engagement: This activity encourages the baby's continuous participation because it allows them to move independently within the confines of the supportive inner tube environment. Moreover, appropriate activity adaptations for the family may be recommended to ensure that this activity is performed frequently and everywhere. For instance, it might be challenging to transport the tube everywhere, so one adaptation could be to perform the same activity between the caregiver's legs.

9. Social: This activity will naturally provide more opportunities for social interaction (e.g., being in a sitting position). In addition, guiding the adults around the baby on appropriate social interaction strategies will support the baby in engaging in more social interaction.

10. Active Engagement and Exploration: This activity provides affordances for active engagement and exploration in an individually tailored physical and social environment. For instance, for the baby who could not move out of a sitting position, it provides opportunities to do so and actively explore the environment within the child's reach.

Analysis

Confidence intervals derived from population data on the PDMS-2 and ABAS-3 serve as a valid method for assessing whether the variability in pre-post scores is attributable to chance. A 95% confidence interval was utilized for each score on the PDMS-2 and ABAS-3. Pre-post scores exhibiting non-overlapping confidence intervals signify effect sizes exceeding 1 and are considered as results unlikely to arise by coincidence, hence showing real change. The assessment manuals of the PDMS-2 and ABAS-3 provided essential confidence interval data.^{46,49} Confidence intervals were not provided in the manual for the TSFI, so categorical changes were analyzed for this assessment. The GAS scores were transformed into T-scores to evaluate the attainment of parent-designated GAS objectives. A t-score of 45 or above signifies that the infant has achieved or is above the expected outcome goals.^{53,54}

Results

A 10-month-old infant at risk for ASD, exhibiting social-emotional and motor developmental delays along with sensory function difficulties, completed the 11-step process of the HEP® Approach as outlined in the HEP® Approach implementation guide. The parents regularly participated in all 10-week sessions, indicating no adverse events during the intervention. Following the intervention, parents reported that the intervention process was comprehensible, practical, and sustainable. The therapist administering the intervention stated that both the parents and the infant exhibited considerable participation in the suggested activities in both the clinical and home environments. Furthermore, the therapist emphasized that she could effortlessly implement the HEP® Approach with an infant at risk for ASD, as outlined in the implementation guide. She stated that the strategies used throughout the intervention improved the infant's regulatory abilities and motivation for movement and interaction.

Table 1. The PDMS-2 gross motor, fine motor, and total scores with 95% confidence intervals.

PDMS-2 Scores	Quotient Score		95% Confidence Interval	
	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention
GMQ	85	96	79-91	90-102
FMQ	88	103	82-94	97-109*
TMQ	85	98	81-89	92-104*

Note. An "*" indicates significant changes in the Gross Motor Quotient (GMQ), Fine Motor Quotient (FMQ), and Total Motor Quotient (TMQ) post-intervention.

Table 2. Distribution of TFSI scores across categories before and after the intervention.

Categories	Tactile Deep Pressure	Adaptive Motor Functions	Visual-Tactile Integration	Ocular-Motor Control	Vestibular Stimulation	Total Score
Cut-Off Scores for 10-12 Month Ages	9-10 (T) 8 (AR) 0-7 (D)	14-15 (T) 13 (AR) 0-12 (D)	9-10 (T) 7-8 (AR) 0-6 (D)	2 (T) 1 (AR) 0 (D)	10-12 (T) 9 (AR) 0-8 (D)	44-49 (T) 41-43 (AR) 0-40 (D)
Infant's Score BI	9	9	10	2	11	41
Cut-Off Scores for 13-18 Month Ages	9-10 (T) 8 (AR) 0-7 (D)	15 (T) 14 (AR) 0-13 (D)	9-10 (T) 7-8 (AR) 0-6 (D)	2 (T) 1 (AR) 0 (D)	11-12 (T) 10 (AR) 0-9 (D)	44-49 (T) 41-43 (AR) 0-40 (D)
Infant's Score AI	10	13	10	2	12	47

Note. Bold text indicates the range corresponding to the child's obtained score. The abbreviations used in the table are as follows: AI = After Intervention; BI = Before Intervention; T = Typical; AR = At Risk; D = Deficient.

Table 3. ABAS-3 General Adaptive Composite (GAC) and adaptive domain standard scores with 95% confidence intervals.

Overall Score	Standard Scores		95% Confidence Interval	
	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention
GAC	85	95	80-90	91-99*
Conceptual	80	95	72-88	88-102
Social	96	95	88-104	87-103
Practical	88	97	78-98	91-103

Note. An "*" indicates significant changes in overall score post-intervention.

The PDMS-2 results revealed that FMQ and TMQ scores had no overlapping confidence intervals, suggesting a significant improvement in fine motor and total motor performance after the HEP® Approach intervention. Although there was an increase in GMQ scores, the confidence intervals overlapped (see Table 1).

Discussion

The primary aim of this study was to examine the implementation of the HEP® Approach with a 10-month-old infant with elevated risk of ASD, motor developmental delay, and sensory processing and integration difficulties. Although the HEP® Approach is known to be safe, feasible, and

acceptable for implementation in premature infants³⁹, the applicability of its principles to infants at risk of ASD is unknown. In this case study, we were able to apply the HEP® Approach in accordance with the HEP® Approach intervention guide³⁹ with a 10-month-old infant at risk for ASD. There were no reported adverse events during the intervention. Furthermore, the interview with parents and the implementing physiotherapist yielded positive feedback regarding the applicability, safety, and acceptability of the HEP® Approach.

Table 4. Goal Attainment Scale post-intervention.

Goal	Much Less Than Expected Outcome -2	Somewhat Less Than Expected Outcome -1	Expected Outcome 0	Somewhat More Than Expected Outcome +1	Much More Than Expected Outcome +2
1.	When A is sufficiently motivated to retrieve a toy that is out of reach, he does not attempt to assume the 4-point crawling position.	When A is sufficiently motivated to retrieve a toy that is out of reach, he attempts to assume the 4-point crawling position but is unable to do.	When A is sufficiently motivated to retrieve a toy that is out of reach, he can assume the 4-point crawling position 1-2 times out of 10 trials.	When A is sufficiently motivated to retrieve a toy that is out of reach, he can assume the 4-point crawling position 3-4 times out of 10 trials.	When A is sufficiently motivated to retrieve a toy that is out of reach, he can assume the 4-point crawling position 5-6 times out of 10 trials.
2.	When A encounters an unexpected situation out of home (i.e., new people trying to communicate with him at the restaurant or unexpected sounds) that stresses him out, he frequently (90–100% of the time) needs the mother's support to calm down.	When A encounters an unexpected situation out of home (i.e., new people trying to communicate with him at the restaurant or unexpected sounds) that stresses him out, he frequently (70–80% of the time) needs the mother's support to calm down.	When A encounters an unexpected situation out of home (i.e., new people trying to communicate with him at the restaurant or unexpected sounds) that stresses him out, he frequently (50–60% of the time) needs the mother's support to calm down.	When A encounters an unexpected situation out of home (i.e., new people trying to communicate with him at the restaurant or unexpected sounds) that stresses him out, he frequently (30–40% of the time) needs the mother's support to calm down.	When A encounters an unexpected situation out of home (i.e., new people trying to communicate with him at the restaurant or unexpected sounds) that stresses him out, he frequently (10–20% of the time) needs the mother's support to calm down.
3.	A stands supported by his parents and bears weight on her feet for less than 15 seconds while he is motivated to play with the toy on the coach.	A stands supported by his parents and bears weight on her feet for 15-20 seconds while he is motivated to play with the toy on the coach.	A stands supported by his parents and bears weight on her feet for 25-30 seconds while he is motivated to play with the toy on the coach.	A stands supported by his parents and bears weight on her feet for 35-40 seconds while he is motivated to play with the toy on the coach.	A stands supported by his parents and bears weight on her feet for 45-50 seconds while he is motivated to play with the toy on the coach.
4.	In the home environment, the baby responds to a communication cycle initiated by one of the caregivers (mother or father) and is not able to maintain.	In the home environment, the baby responds to a communication cycle initiated by one of the caregivers (mother or father) and maintains this for 1-10 seconds.	In the home environment, the baby responds to a communication cycle initiated by one of the caregivers (mother or father) and maintains this for 11-20 seconds.	In the home environment, the baby responds to a communication cycle initiated by one of the caregivers (mother or father) and maintains this for 21-30 seconds.	In the home environment, the baby responds to a communication cycle initiated by one of the caregivers (mother or father) and maintains this for 31-40 seconds.
5.	When his parents motivate him with a toy, he can tolerate tummy time less than 1 minutes.	When his parents motivate him with a toy, he can tolerate tummy time for 1–2 minutes.	When his parents motivate him with a toy, he can tolerate tummy time for 3–4 minutes.	When his parents motivate him with a toy, he can tolerate tummy time for 5–6 minutes.	When his parents motivate him with a toy, he can tolerate tummy time for 7–8 minutes.

Note. Bold areas indicate the level of achievement as rated by parents post-HEP® Approach intervention.

Confidence interval analysis indicates a significant improvement in fine and total motor skills post-intervention. Despite notable

improvements in gross motor skills, the confidence intervals displayed overlapped. The data from this case study is similar to previous research, indicating

that the HEP® Approach promotes motor development in infants^{31,32,39} and significantly improves the gross motor, fine motor, and total motor skills of preterm infants aged 4 to 10 months.³⁹ Furthermore, these results align with earlier research indicating that EE-based early interventions in infants promote motor development.^{40,41} A recent study by Lima et al. (2023) demonstrated that the EE-based STEP protocol improved motor skill performance in infants at risk of developmental delays.⁴¹ In another study, Apaydin et al. (2023) showed that the SAFE early intervention approach, also based on EE, had more effective results than traditional intervention in motor development in premature babies.⁴⁰

The categorical change in the total score of sensory functions in our study is consistent with studies showing the positive effects of the HEP® Approach on sensory functions.^{32,39} Furthermore, other studies demonstrating the positive effects of EE-based early intervention on sensory functions support these findings.⁴⁰ The improvement of sensory functioning in this study may be ascribed to the infant's increased involvement in active exploration and related sensory experiences resulting from the development of motor abilities.^{32,39,56}

The confidence interval analysis reveals a notable improvement in ABAS-3 the General Adaptive Composite (GAC) score following the HEP® Approach intervention although the confidence intervals overlapped in conceptual, social, and practical domains. The significant change in GAC indicates a relationship with enhanced motor development scores on ABAS-3. Indeed, the GAC domain solely incorporates the motor subdomain when computing ABAS-3 domain scores.⁴⁹ The PDMS-2 performance test findings align with the ABAS-3 parent scale. Moreover, we can assume that the infant's improved adaptive capabilities are associated with the development of more mature motor skills. Our findings are consistent with studies showing that motor skills are associated with adaptive behaviors.⁵⁷⁻⁵⁹ Fears et al. (2022) demonstrated in their research that motor skills correlate with adaptive behavior scores in individuals with ASD.⁵⁹ Moreover, Estes et al. (2015) proposed that early intervention for infants at risk of ASD should consider motor development support due to the significant relationship between fine and gross motor skills and adaptive behavior skills in young children with ASD.⁵⁷ While the

impact of the HEP® Approach on adaptive behaviors remains unknown, it can be hypothesized that its beneficial impacts on motor development in infants^{32,39} could improve their adaptive behavior capabilities.⁵⁷⁻⁵⁹

Our findings revealed a t-score of 74.12 on the GAS, indicating significant progress in parental goals as assessed by the GAS. In four of the five goals (three of which were motor skill-based and one related to regulatory capacity), there was an improvement of "Much More Than Expected Outcome." In the goal related to communication, there was an improvement consistent with the "Expected Outcome." These findings are consistent with studies demonstrating that the HEP Approach positively affects parental goals measured with GAS in infants.^{32,39} Other studies corroborate these findings, demonstrating the beneficial impact of EE-based early intervention approaches on parental goals.^{40,60} The achieved motor goals are consistent with our PDMS-2 results. Positive developments in regulation and communication-related goals may suggest a relationship with improved motor skills.^{12,15,61}

Several difficulties emerged during the intervention, contributing to contextual limitations. Notably, the infant's mother was the sole caregiver throughout the 10-week intervention period due to limited social support and the father's demanding work schedule. As a result, the mother frequently reported feeling fatigued, which negatively impacted her consistency and motivation in carrying out certain aspects of the home program. A specific challenge involved the irregular submission of home videos, a critical component of the HEP® Approach's follow-up and fidelity monitoring process. Although the family expressed general motivation for the intervention, the mother noted that her difficulty in consistently recording and sending videos stemmed from the burden of managing caregiving responsibilities alone. These observations highlight the critical role of social support in sustaining caregiver engagement and underscore the need to consider caregiver capacity when designing and implementing home-based early intervention programs.

The main limitation of this study arises from the methodological critiques commonly directed at case reports, particularly the assertion that a single case lacks significance due to inadequate generalizability.

The aim of this case report is not to generate generalizable knowledge but rather to investigate the implementation of the HEP® Approach with an infant at risk for ASD. Secondly, the brief intervention duration may have led to changes in standard scores that lacked statistical significance due to substantial standard measurement errors. However, a strength of this case report was the use of blind examiners for the standardized administered assessments, along with the documentation of the clinical reasoning process and adherence to the fidelity standards of the HEP® Approach.

Conclusions

This case report is the first to demonstrate the implementation and effectiveness of the HEP® approach in an infant at risk for ASD and with developmental delays. The HEP® approach positively affected motor development, sensory functions, general adaptive skills, and parental goals in a 10-month-old infant at risk for ASD. However, the study design precludes generalizing the case report's results. Moreover, this study motivates further research into the feasibility and effectiveness of the HEP approach in infants at risk for ASD.

Declarations

Supplementary Materials

The following supporting information can be downloaded at:

<https://www.mdpi.com/article/doi/s1>, Figure S1: title; Table S1: title; Video S1: title.

Author Contributions

A.B.: Conceptualization, methodology, validation, formal analysis, investigation, writing—original draft preparation, writing—review and editing, project administration, supervision. A.F.A.B.: Data curation, formal analysis, writing—review and editing, resources. I.M.D.: Investigation, visualization, formal analysis, data curation, writing—original draft. G.C.S.: Investigation, methodology, formal analysis, data curation, writing—original draft. I.B.-B.: Validation, formal analysis, writing—review and editing, supervision. T.A.M.-B.: Methodology, validation, formal analysis, writing—original draft preparation, writing—review and editing, supervision. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

This case report was deemed exempt from ethics review given that all data collected was done as part of clinical practice and all personal information was de-identified. Furthermore, informed consent was obtained in accordance with Helsinki guidelines.

Informed Consent Statement

Parents provided written informed consent for the publication of this manuscript.

Data Availability Statement

All the data are included in the manuscript.

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Conflicts of Interest

Teresa May-Benson is the owner of the company TMB Educational Enterprises, LLC., and has no conflict of interest or financial interest. Aymen Balikci is the owner of the company Sense On, Ltd., and has no conflict. They are affiliated with private businesses, but there are no financial conflicts of interest. The authors declare no conflicts of interest.

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Appendix A

Table A. Description of the HEP® Approach Phases for Case A with Examples.

Program Phase	Description	Examples
Referral	The child psychiatrist and special education specialist referred the child due to difficulties in the sensory-motor area.	The infant, who received medical and early intervention evaluation mainly due to social interaction problems, was referred to a physiotherapist because of delays in motor development and unpredictable responses to sensory stimuli.
Family Introduction	The initial meeting familiarizes the family with the intervention methodology, theoretical framework, our identity, our functions, and the overarching philosophy of the HEP® Approach for infant development. The family's systemic strengths and limitations are recognized.	The influence of the environment on development was emphasized. For example, the parents' well-being contributes to the infant's development. An explanation of the HEP approach's dynamic systems background, such as how each developmental area can influence other areas was provided. For example, poor motor development performance may affect a baby's social capacities, while improved motor performance may enhance them.
Comprehensive Assessment	A comprehensive assessment is conducted in the clinical environment. Observations are made regarding the interactions between the family and the child. A crucial component of the evaluation entails monitoring the child while he actively explores the environment and objects using hands, feet, eyes, and/or ears in various postures (supine, prone, and sitting).	The evaluation procedure that informs the intervention encompasses the analysis of the child's homeostasis, sensory processing, and domains of emotional, motor, and cognitive development. Furthermore, the developmental history and family interview attempt to understand the child's prior experiences, the services they presently get, their future aspirations, and their social and physical environment.
Identification of Strengths and Challenges of the Child and Parent Based on Assessment	The thorough assessment interpretation reveals the fundamental child, family, and environmental challenges that restrict the infant's engaged exploration and participation.	The father's calm and inclusive nature and the baby's good trunk control in sitting are strengths for the family and the baby. Mother's stress, the baby's limited regulatory capacity, and poor motor skills are areas of difficulty for the family and the child.
Formulation of Hypotheses	The hypotheses regarding the underlying variables that either hinder or facilitate the child's development are articulated, and our hypotheses are presented to the parents.	The mother's stress restricts the baby's social-emotional, sensory, and motor development, whereas the father's support and inclusiveness foster a social environment conducive to the development of these areas. The infant's proficient sitting abilities facilitate development of his manipulation skills. The infant's high stress level or poor regulatory capability impacts his ability to interact with the environment (objects and people). The infant's limited locomotion hinders his capacity to explore and engage with his environment.
Collaborative Goal-Setting	The family collaborates with the clinician to create intervention goals. Goals are based on the child's limitations and the family's fundamental concerns.	As the infant's regulation abilities develop, he will engage easier with those in his immediate environment. As the infant's locomotor abilities advance, he will engage more with the environment and interact more frequently with people.
Identification of Outcome Measures	Appropriate monitoring tools and measures are selected, and information is shared with the family.	Goal Attainment Scaling, Peabody Developmental Motor Scales-2, Test of Sensory Functions in Infants, and Adaptive Behavior Assessment System Third Edition (ABAS-3).
Intervention Planning	The features of the HEP® Approach are explained to the family, ensuring that they understand the program's scientific theoretical foundation. The family receives information about their child's HEP® Approach intervention's location, frequency, and duration.	Sessions are scheduled for one hour each week in the clinic for a duration of ten weeks, accompanied by recommendations for home activities and weekly video follow-ups.
Intervention	The first 1-4 sessions focus on strategies to promote homeostasis and self-regulation as well as the baby's basic	Recommendations were provided for the mother to self-regulate. It was suggested that she consult a mental health expert for support. Family interactions were

needs, including sleep patterns, feeding habits, sense of safety, and regulatory capacity.

designed to enhance the infant's regulating abilities and sense of security.

Within the scope of the HEP® Approach, caregiver well-being was recognized as a crucial component influencing the effectiveness and sustainability of home-based interventions. Considering that the mother served as the infant's primary caregiver during most of the day, she was advised to engage in regular deep breathing exercises to support her own autonomic regulation and mitigate stress-related fatigue. Moreover, it was recommended that the mother dedicate at least one uninterrupted hour per day to self-directed, intrinsically motivating activities following the father's return from work, thereby facilitating caregiver restoration and promoting balanced familial dynamics.

In parallel, strategies to enhance the infant's regulatory capacity were emphasized. The therapeutic team highlighted the developmental importance of enabling frequent opportunities for physical activity throughout the day. To this end, the use of age-appropriate and safe equipment—such as infant jumpers—was recommended to facilitate active movement and sensory-motor engagement. Additionally, the family received guidance on environmental modifications to optimize the infant's sense of safety. This included ensuring spatial predictability within the home and providing the infant with verbal and contextual cues in unfamiliar environments to support orientation and reduce anxiety. These recommendations were framed within the broader goal of establishing a secure, enriched, and responsive environment to promote optimal developmental outcomes.

Sessions 2-6 focus on organizing the physical and social environment in the home environment to support the baby's active exploration, considering the individual differences between the infant and the family.

The physical environment and activity configurations were designed to facilitate the baby's transition from a sitting position to an alternative position. The infant was positioned within a inner-tube and encouraged to explore objects beyond its confines. Thus, the infant discovered to transition from a seated position to various postures. In addition, the physical environment was structured to allow the infant to independently initiate supported standing and safely perform positional transitions without the risk of falling, thereby promoting autonomy in motor exploration. The family was also provided with guidance on the appropriate use of equipment such as baby walkers and bouncers to facilitate the infant's active exploration of both the body and the surrounding environment, including instructions on how to adjust these tools to align with the infant's individual developmental needs and capabilities. Caregivers were also informed to support the baby's feelings through gestures and facial expressions to facilitate the baby's active exploration.

The 4th-8th sessions guide the family to diversify the capacities the baby has acquired. They receive guidance to apply the same skill in diverse settings, experimenting with various objects and individuals.

Parents were advised to provide developmentally appropriate opportunities for motor exploration practice by utilizing familiar household settings. For instance, when the infant is able to sit independently within a laundry basket, they may practice postural control with minimal lateral support provided by pillows placed at their sides. Similarly, once the infant demonstrates the ability to perform transitional movements within an inner tube, they can be encouraged to practice these transitions while seated

		between cushions to enhance stability and motor planning. When the infant is capable of crawling on a flat surface, caregivers were encouraged to facilitate crawling over floor cushions of varying heights to promote strength, coordination, and sensory input. Furthermore, when the infant begins to exhibit transitional movements in a vertical position—such as those performed within a cylindrical support—parents were guided to support similar activities using the edge of stable furniture (e.g., a sofa) to encourage safe weight shifting and standing. In addition, rather than relying on conventional baby walkers, caregivers were encouraged to introduce push-friendly objects, such as lightweight chairs, to promote self-initiated and supported exploration of the home environment.
	In sessions 6-10, families are supported in making appropriate environmental arrangements, tool adaptations, object selection, division, and difficulty adjustments to support their babies' active exploration through reflective questions provided by the clinician. The family's self-efficacy in supporting their babies' development is increased.	As part of the caregiver coaching process, parents were shown video excerpts in which their infant demonstrated increased interaction and active exploration of movement capabilities, objects, and the surrounding environment. During these reflective discussions, parents were prompted with guiding questions such as, "What do you think contributed to the increase in interaction currently?" or "How did the environment support your baby's engagement here?" This strategy aimed to enhance parental awareness of affordances in the environment and to promote their ability to recognize and replicate supportive interactional contexts. For example, in one video segment, the infant—while placed inside an inner tube—actively moved to reach for a toy, prompting increased vocalization and joint attention with the parent. Parents were asked to reflect on how the physical boundaries and "the just right challenge" provided inside the tube may have contributed to this engagement. In another instance, the infant demonstrated sustained crawling over cushions of varying heights, accompanied by spontaneous smiling and increased orientation toward the caregiver. The therapist used this clip to facilitate discussion on how physical challenge, caregiver proximity, and positive affect may have jointly supported the infant's motor exploration and social responsiveness.
Family Home Follow-Up and Monitoring	The family is supported in incorporating these strategies into every aspect of their daily life at home. The family is monitored by sharing videos on WhatsApp. The therapist provides feedback on the family's videos, assisting them in developing new strategies.	A video depicted an infant being prompted to kick a ball while in a baby bouncer. The family received feedback indicating that the task would be difficult for the infant, emphasizing the significance of the baby exploring mobility with his feet.
Evaluation of Intervention Effectiveness	At the end of the intervention period, an evaluation of the intervention's effectiveness is completed. Outcome measures are readministered, and progress toward goals is measured.	The results indicate that the infant achieved all five goals on the GAS or that his Total Motor Scores improved significantly on the Peabody Developmental Motor Scales-2.