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Content Validity and Preliminary Structural Validity of the Sensory Integration Infant Routines Questionnaire

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ABSTRACT

This study examined the content validity and preliminary structural validity of the Sensory Integration Infant Routines Questionnaire (SIIRQ), a tool designed to screen for behaviors reflecting possible sensory integration concerns in children aged between 8 and 24 months. This study included two main phases. In phase 1, we examined content validity through cognitive interviews with experts and caregivers. In phase 2, we explored preliminary structural validity through item discrimination, analyzing the dispersion of responses within the 4-point Likert scale. Preliminary internal consistency using Cronbach's alpha was also explored. Experts demonstrated a high degree of agreement, and their input was useful in establishing items to help identify sensory integration vulnerabilities within daily routines. Caregivers unanimously reported that the instrument and the instructions were easy-to-understand. The questionnaire item responses demonstrated good dispersion and appear to capture behaviors that are consistent with sensory integration concerns in daily routines. The homogeneity of the items within each dimension (Cronbach's alpha) ranged from 0.60 to 0.87. The final version of the questionnaire includes 102 items aimed at detecting sensory integration vulnerabilities within the child's daily routines, in accordance with currently accepted models of early intervention.

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Activities of daily living; infants; routines; sensory integration; sensory integration concerns; validation of assessment instruments

Introduction

The importance of early screening, assessment, and intervention planning for infants, toddlers, and young children with sensory integration disorders is crucial in the areas of education and health (Mailloux et al., 2014; Schoeman, Swanepoel, & van der Linde, 2017; Smith-Roley, Singer, & Roley, 2016). If professionals and caregivers understand the differences in sensory tolerances and preferences, they are better able to create environments that encourage the development of very young children. This knowledge allows for the implementation of strategies to better support infants' and toddlers' management of their

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reactions to sensory input and for the regulation of their own behavior (Williamson & Anzalone, 2001).

Sensory integration is a term that originated from the work of Dr Jean Ayres (1969, 1972). Many other sensory-based approaches have appeared in recent years and to avoid confusion around sensory integration theory, a trademark for the term Ayres Sensory Integration® (ASI) was established (Smith-Roley, Mailloux Heather Miller-Kuhaneck, Glennon, & Roley, 2007). Consistent with the work of Ayres, sensory integration is defined as the capacity of the central nervous system to receive, modulate, and interpret sensory information from the body and the environment in order to respond appropriately and meet the demands of everyday life (Schaaf et al., 2014; Smith-Roley et al., 2016). Sensory integration abilities develop naturally, but they can also be stimulated, and play an important role in learning, behavioral and emotional regulation, motor development, and task performance (Pfeiffer, May-Benson, & Bodison, 2018a). However, a considerable number of children with and without disabilities are affected by challenges when processing and integrating sensations. Research suggests that 5%–20% of children without diagnosed disabilities have difficulties in this area, which consequently affects the child's ability to participate in daily activities (Flanagan, Schoen, & Miller, 2019; Galiana-Simal et al., 2020; Mulligan et al., 2019; Pfeiffer et al., 2018a).

In recent years, sensory integration disorders have been recognized in three diagnostic classification reference manuals: 1) Diagnostic Classification of Mental Health and Developmental Disorders of Infancy and Early Childhood, revised (known as DC: 0–5) (Zero to Three, 2021); 2) Diagnostic Manual for Infancy and Early Childhood, published by the Interdisciplinary Council on Developmental and Learning Disorders (Interdisciplinary Council on Developmental and Learning Disorders, 2000); and 3) Psychodynamic Diagnosis Manual (Lingiardi & McWilliams, 2017). There is a clear need to identify challenges in detecting, interpreting, and adaptively responding to sensory input given the impact on a child's ability to participate in meaningful occupations during daily routines, as well as on many developmental milestones (Mulligan et al., 2019; Pfeiffer et al., 2018a; Schaaf & Nightlinger, 2007; Schaaf et al., 2014; Zakorchemny & Lashno, 2019).

Researchers have found that infants with sensory integration disorders may be fussier and that they have more difficulty establishing typical meaningful human interactions, which causes a huge impact on mother-infant coregulation, and consequently affects involvement in co-occupations (Smith-Roley et al., 2016; Williamson & Anzalone, 2001). Infants and young children with sensory integration disorders tend to have difficulties in several areas, such as feeding, toileting and toilet training, washing hair, trimming nails, brushing teeth, dressing, wearing shoes, and behavior regulation to meet environmental demands (Beaudry-Bellefeuille, Bundy, Lane, Ramos Polo, & Lane, 2019; Flanagan et al., 2019; Mulligan et al., 2019). Children with sensory issues tend to have excessive difficulty accepting new kinds of foods, display overreaction or a defensive reaction, such as grimacing or gagging in response to sensory inputs related to taste, texture, or smell (Blissett & Fogel, 2013). Appleyard et al. (2020) found a link between sleeping patterns and sensory integration difficulties in toddlers.

Other researchers have documented that atypical responses to sensory experiences, particularly hyperreactivity, are correlated with a reduction in the quality of sleep and disrupted sleep in children without disabilities (Foitzik & Brown, 2018; Shochat, Tzischinsky, & Engel-Yeger, 2009). Difficulties with sensory integration can negatively

affect the ability to play, such as less active play, more sedentary play, less socially interactive play, and shorter periods of time in play with toys and with the surrounding space (Ayres, 1972; Watts, Stagnitti, & Brown, 2014). Specifically, a child's praxis skills and abilities to adequately perceive touch, visual, proprioceptive, and vestibular information may interfere with the ability to interact and to play with people and objects (Watts et al., 2014).

Objective valid assessment is needed to understand how issues in sensory integration and praxis interfere in the development and participation of children in activities of daily living (Mailloux et al., 2014). Thus, considering the direct relationship between sensory integration disorders and participation, it is important to identify them in a timely manner, emphasizing the role of the family in the evaluation, the behavior of the child in daily activities and the various contexts where these activities take place (home, community) (DeGangi, 2017; Hemmeter, Joseph, & Smith, 2014).

Although efforts are currently underway to validate caregiver questionnaires that assess sensory systems and the constructs of ASI in Portuguese children aged between 4 and 24 months (Gomes et al., 2016; Reis, Gomes, & Dixe, 2019; Reis, Neves, & Dixe, 2020), there exists an absence of validated instruments, which contemplate sensory integration concerns specifically linked to participation within natural environments and family routines, key components of accepted practice in early intervention (McWilliam, 2016). It therefore becomes relevant to construct and validate the Sensory Integration Infant Routines Questionnaire (SIIRQ). The SIIRQ is anchored in ASI theory, which proposes that integration of sensory information is a critical neurobehavioral process that strongly affects human development. Smith-Roley et al. (2016) developed a model for describing the four sensory integration dysfunction patterns of young children: sensory over-responsive/defensive, sensory under-responsiveness, poor posture/ocular-motor, poor praxis including planning/sequencing (Smith-Roley et al., 2016). The model developed by Smith-Roley et al. (2016) is based on several studies with older children (Ayres, 1965, 1966, 1971, 1972, 1977, 1989; Mailloux et al., 2011; Mulligan, 1996, 1998, 2000) which have consistently obtained the following patterns: visuopraxia/visuodyspraxia (difficulty with the perception of shape and space, visuomotor coordination and visual construction), somatopraxia/somatodyspraxia (characterized by tactile and proprioceptive discrimination problems), bilateral integration deficit and vestibular-based sequencing (characterized by problems of vestibular and proprioceptive discrimination), and a pattern of sensory reactivity (refers to the regulation by the central nervous system of its own activity) (Mailloux et al., 2011).

Materials and Methods

Recent reviews in psychometrics highlight the need to carefully examine the quality of patient and caregiver questionnaires before they can be used in research and practice. The COSMIN (COnsensus-based Standards for the Selection of Health Measurement Instruments) initiative recommends evaluating three quality domains: reliability, validity, and responsiveness. This study has focused mainly on the validity domain of the SIIRQ. In relation to validity, COSMIN delineates the following areas: content validity (including face validity), construct validity (structural validity, hypotheses testing, cross-cultural validity), and criterion validity. In accordance with the recommendations of COSMIN (Mokkink, Prinsen, Bouter, Vet, & Terwee, 2016) and others (Almeida & Freire, 2017), we have focused on content validity in this early phase of development of the SIIRQ.

We also explored preliminary structural validity of the SIIRQ. We did this through analysis of item discrimination by examining the spread of responses across the 4-point Likert scale to assess the capacity of the items to differentiate among individuals, aiming to include items with a uniform spread across response categories in order to yield the best differentiation (Cappelleri, Lundy, & Hays, 2014). Reliability was also explored by examining preliminary internal consistency using Cronbach's alpha (Almeida & Freire, 2017) aiming to obtain acceptable values (>0.60 ; Taber, 2018) in each of the seven dimensions. The study was approved by the research Ethics Committee of the University of Minho (CEICSH Process 123/2020).

Phase 1

Identification of the Items

To choose and group the various items that would constitute the SIIRQ, we considered as dimensions the child's basic routines: Awakening/Nap/Bedtime; Diaper changing/Sphincter Control; Dressing/Undressing; Breastfeeding/Feeding/Meals; Bathing Time/Hygiene Activities; Getting Ready to Go Out/Travelling/Community; and Playing. The choice of these seven dimensions was based on McWilliam's Routines-Based Interview (McWilliam, 2010). According to the author, the evaluation based on contexts and, more specifically, on the child's and caregivers' routines is extremely important to identify the child's behaviors, to determine needs, as well as to identify the concerns of the family as a whole (McWilliam et al., 2020).

We then proceeded to create items that would represent the four sensory integration dysfunction patterns of young children across each of these seven dimensions. For example, in the dimension of *Breastfeeding/Feeding/Meals*, the item *Avoids touching food with their hands (e.g., raw, sticky, wet food)*, represents the Sensory Over-Responsive/Defensive Pattern. Based on a review of relevant literature, parent description of behaviors that are common to many children who referred to occupational therapy for sensory integration issues, and existing evaluation tools in the field of sensory integration, we created items to reflect sensory integration concerns contextualized in family routines and natural environments.

We revised the Sensory Processing Measure for Preschoolers (Ages 2–5 yrs.; Parham, Ecker, Kuhaneck, Henry, & Glennon, 2007), the Sensory Profile 2 (Ages 0–14.11 yrs.; Dunn, 2014), the Test of Sensory Functions Infants (Ages 4–18 mo.; DeGangi & Greenspan, 1989), the Preschool Imitation and Praxis Scale (Ages 1.5–4.9 yrs.; Vanvuchelen, Roeyers, & De Weerd, 2011), the Infant-Toddler Symptom Checklist (Ages 7–30 mo.; DeGangi, Poisson, Sickel, & Wiener, 1995), the Sensory Experiences Questionnaire (Ages 2–12 yrs.; Baranek, 1999), the Toileting Habit Profile Questionnaire-Revised (Ages 3–6 yrs.; Beaudry-Bellefeuille et al., 2019), the Sensory Rating Scale (Ages 0–3 yrs.; Provost & Oetter, 1994) and the Participation and Sensory Environment Questionnaire (Ages 3–5 yrs.; Pfeiffer et al., 2018b).

Faced with the choice of an instrument written in a foreign language, which would need to be translated and adapted, or with the construction of our own instrument, our choice fell on the latter option. From this perspective, we considered building an instrument consistent with ASI and consistent with the parameters advocated by current approaches to early assessment/

intervention, namely the importance of gathering information about the natural contexts of the child's and the family's life, the clear identification of the child's behavior during daily activities, and the active and preponderant role of the family throughout the evaluation process (Bagnato, Goins, Pretti-Frontczak, & Neisworth, 2014; Macy, Glascoe, Ji, Macy, & Zhang, 2017). Therefore, although some items of the SIIRQ were inspired from existing items from other instruments, all SIIRQ items are original, based on clinical experience and specifically written to clearly reflect sensory integration concerns within routines, using descriptions of behaviors that caregivers are likely to observe and examples that are easily understandable. All efforts were made to create items that would reflect the child's experience of the routine, using descriptive terms compatible with caregiver observation.

Thus, the collected sensory integration items were carefully distributed according to the seven dimensions of daily routines previously defined. For example, in the Dressing/Undressing dimension (McWilliam, 2010) we included sensory items such as *Passive posture during dressing/undressing (e.g., does not cooperate: does not offer the arm to put it in the sleeve)* which is linked to dressing and represents the Poor Praxis/Planning/Sequencing pattern (Smith-Roley et al., 2016). The selected items provide descriptive information about sensory integration vulnerabilities in all of the ASI patterns described in the Smith-Roley et al. model (2016), which influence participation in daily life activities of children aged between 4 and 24 months and their families (DeGangi, 2017; Nesayan, Asadi Gandomani, Movallali, & Dunn, 2018; Smith-Roley et al., 2016).

Response Scale

A 4 response options Likert scale was defined: (1) The behavior Almost Never or Never occurs; (2) The behavior Rarely occurs; (3) The behavior occurs Often or Quite Often; and (4) The behavior occurs Almost Always or Always. Considering that there is a possibility that the user will not be able to answer to certain items due to lack of information, because the item does not correspond to the age of the baby/child, we included the option Not applicable. This option was not treated as a description of the child's behavior, but as a real answer due to lack of information. Following the assumptions of psychometrics, we chose not to include in the Likert scale a central point (The behavior occurs Occasionally or Sometimes) to avoid excessive use of this response which would significantly reduce the spread of responses across the Likert scale, given that users tend to centralize their responses when an intermediate point is available (Brace, 2008).

The SIIRQ instructions reinforce the importance of selecting the type of answer that best describes the frequency with which the child manifests the described behaviors. In order to ensure the rigor of the construction of the SIIRQ, we complied with the Lima Guidelines : 1) Preparation of a list of sentences that express clearly positive or negative opinions regarding the attitude that is being studied, taking care to cover the different aspects that relate to the construct; (2) Use of a representative sample of the population to which the scale under construction is to be applied; and 3) Diversify the degree or frequency of the answers; for example, in the study in question it is intended that users manifest the frequency of certain behaviors in a gradual scale of four points (ranging from 1 – Almost Never or Never to 4 – Almost Always or Always) (Lima, 2000).

Content Validity

We analyzed the relevance of the items in relation to the goals of the instrument, their clarity, and their comprehensibility (Almeida & Freire, 2017). To this end, we performed an analysis of the validity of the content of the items, using cognitive interviews, first with seven occupational therapists with advanced training and experience of at least 6 years in ASI; and then with 6 caregivers with identical characteristics of the future recipients of the SIIRQ. In the cognitive interviews with the experts, we analyzed: (1) the relevance of the 7 dimensions of the SIIRQ; (2) the organization of items and their relevance in each dimension; and (3) the assessment of the adequacy of the items in each dimension and the need to include new items. Cognitive interviews were carried out with the caregivers to identify possible ambiguities in the content and in the format of the items and to check the suitability of the various response options on the Likert scale. The interviews were also intended to identify poorly constructed items, evaluate the clarity of the instructions for use of the SIIRQ, as well as estimate the difficulty of understanding the items and the time needed to fill the scale. Our goal was to make a user-friendly scale, easy to comprehend, regardless of academic qualifications and socio-economic status.

Phase 2

Quantitative Analysis

Following phase 1, we conducted a quantitative study, considering the capacity of the items to discriminate among participants and the possible elimination of items lacking an adequate spread of responses across the Likert scale options. Items for which 85% or more of the caregivers responded Never or Almost Never, were removed from the questionnaire. Our intent was to identify the most relevant items in order to shorten the questionnaire as to facilitate parent engagement in the use of our screening tool, concerned with the fact that a long questionnaire could discourage parents from responding to all of the items. We also wanted to retain the items with potential to detect developmental trends. The items were created with the purpose of detecting sensory integration issues as early as possible and clinical experience shows that most of the SIIRQ items represent problems at all stages of development. For example, in the Playing dimension (McWilliam, 2010), the item *Negative/exaggerated reactions in games involving the caregiver's touch (e.g., does not like to be hugged or touched by the parents)* would be considered problematic at all ages. At this point, it is not clear if some of the behaviors represented in the SIIRQ will show a developmental trend or not. For instance, in the Waking up/Nap/Sleeping dimension (McWilliam, 2010) we included sensory items such as *Sleeps for short periods of time (e.g., wakes up several times during the night)*; this behavior may be typical in a 4-month-old baby, however, it may be a concern for parents of older children. This will need to be examined in future studies. Finally, we assessed internal consistency of each of the seven dimensions using Cronbach's alpha. The results obtained were analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 28.0 for Windows.

Participants

We gathered data using a convenience sample of 73 caregivers of infants aged between 4 and 24 months with typical development who were recruited to the study. As the protocols were

collected during the pandemic period, we used friends and colleagues to gather the sample. Caregivers were informed that participation was voluntary and anonymous. All participants signed a consent form prior to the beginning of the study. Regarding the age of the children, we stratified them in three groups: 1) from 4 to 10 months, 2) from 11 to 17 months and, 3) from 18 to 24 months. The option of three groups is related to the child's gradual ability to organize sensory information through increasingly adaptive responses to moments of daily routine. In the first few months, the child will learn to regulate his level of activity and alertness. The child will also learn to organize and interpret sensory inputs with a progressive increase in skills. Thus, up to 10 months of age, the baby acquires a series of fundamental skills in terms of global development, the most visible being motor skills. From that age onwards, the child will be more apt to acquire new skills, manifested in their ability to relate and get involved in daily routines, in a more complex way. From 18 months onwards, the child has greater security in exploring the environment and greater control over the external world (praxis), increasing their participation in daily routines in a richer and more diversified way (DeGangi, 2017).

Results

The experts were in general agreement with the proposed dimensions and organization of items. They suggested rewording of certain items and mentioned the importance of adding examples in order to improve clarity, considering the possibility of the SIIRQ being answered by caregivers of different sociocultural strata (Almeida & Freire, 2017). Suggestions were made to add new items in several dimensions. Changes to items and additional items are detailed in Table 1.

Table 1. Changes made to the items based on expert review.

Dimension	Initial Item	Final Item
Waking up Nap	Item: He/she needs a stable routine to stay calm and relaxed	Rephrase item: He/she presents difficulty sleeping outside his/her household/in another context
Sleeping	Item: He/she rejects the texture of certain fabrics	Rephrase item: He/she is annoyed by the texture of certain fabrics (e.g., quilt, sheet, blankets)
Diaper Changing Sphincter Control	Item: Demonstrates fleeting eye contact during diaper change	Remove item: Not relate to occupational performance
Dressing Undressing	---	Add item: Prefers minimal clothing, even when it's cold
Breastfeeding Feeding Meals	Item: He/she insists that food be offered/presented in a certain way	Rephrase item: He/she insists that food be offered/presented in a certain format (e.g., the same feeding bottle, dish, spoon; the way the food is distributed on the plate)
Bathing Time Hygiene Activities	---	Add item: After bathing, manifests an exaggerated increase in the state of arousal (e.g., more active, impulsive, aggressive behavior) Add item: Expresses an exaggerated pleasure in rubbing the body with the sponge
Getting Ready to Go Out Travelling Community	Item: He/she gets angry/cries when is seated in the car seat Item: He/she gets angry/cries when the seat belt is fastened	Gather items: Negative/exaggerated reaction when sitting in the car seat (e.g., resists putting on seat belts, cries)

All caregivers were unanimous in their assessment, considering the instrument easy to understand except for two items: 1) item 6 (Diaper Changing/Sphincters Control), “*Exaggerated reaction/insecurity/fear when he/she moves his/her head or when he/she is moved during diaper changing*”, caregivers reported that the explanation offered in parentheses was not sufficient and suggested a complementary explanation to better understand the item (“*Shows exaggerated fear when leaned backward during diaper change – e.g., refuses to lean head back in order to lie down, cries, resists*”); 2) item 7 (Getting Ready to Go Out/Travelling/Community), “*He/she presents a negative reaction/avoids crawling/walking barefoot on different surfaces*” caregivers expressed problems understanding the item, so we changed the item to “*He/she avoids crawling/walking barefoot on different surfaces (e.g., beach sand, grass, soil) and is annoyed when he/she has to do it*”). All suggestions made by specialists and caregivers were considered and included in the final version.

Regarding the quantitative study, the participants are distributed as follows: 1) from 4 to 10 months, with 35.5% (n = 26), 2) from 11 to 17 months, with 34.3% (n = 25), and 3) from 18 to 24 months, with 30.2% (n = 22). Of these children, 58.9% are male. The average age of parents was 35.25 years. Most parents (60) had higher education or

Table 2. Items that presented a weak dispersion of results.

Dimension	Items
Waking up	Gets bored/annoyed with the adult’s voice
Nap	Looks drowsy during the day (e.g., looks tired, prostrate, apathetic)
Sleeping	Requires loud noises and loud sounds to fall asleep
Diaper Changing	Shows insecurity/fear when lying on high surfaces (e.g., changing room in the mall, in the restaurant)
Sphincter Control	Expresses an exaggerated pleasure with the smell of his/her feces Seems to feel no desire to defecate Needs entertainment to defecate: helps him tolerate the moment (e.g., use of a toy, cell phone, books) Manifests aversion to the smell of feces Seems to feel pain at the time of defecation, including when the feces are soft Gets annoyed/irritated when cleaning is performed at the time of diaper change (e.g., use of wipes, cream, ointment)
Dressing	Exaggerated reaction to caregiver’s touch during dressing/undressing
Undressing	Ignores the caregiver when he interacts with him/her during the moment of dressing/undressing Prefers to walk in very tight shoes
Breastfeeding	Regurgitates or throws up when seeing certain foods
Feeding	Eats better when he/she is very sleepy or asleep
Meals	Presents difficulties in sucking (e.g., unable to “grasp” the nipple or bottle properly)
Bathing Time	Negative/exaggerated reaction at bathing time (e.g., when approaching the bathtub, when seeing the shower, hearing the water run)
Hygiene Activities	Indifferent to bathing stimuli (e.g., apathy, lack of facial expression) Likes to generate certain sounds repeatedly (e.g., flushing the toilet several times)
Getting Ready to Go Out	Negative reaction/insecurity/fear when exposed to elevators, escalators with the adult
Travelling	Presents a negative/exaggerated reaction in an environment full of stimuli (e.g., on playgrounds, people interacting with him)
Community	Presents a negative/exaggerated reaction when touching toys with different textures Presents a negative/exaggerated reaction to the adult’s voice (e.g., cries, throws tantrums, gets uncomfortable in interactions with the caregiver)
Playing	Presents a negative/exaggerated reaction to toys that emit sounds (e.g., covers ears, avoids them, cries, gets anxious) Presents a negative/exaggerated reaction to toys that have bright colors (e.g., cries, gets angry, walks away) Presents a negative/exaggerated reaction to surfaces/floors with varied textures (e.g., tiles, carpets, blankets, pillows)

a university degree, one parent completed basic education, and 12 parents completed secondary education.

Overall, the results revealed an adequate spread of responses across the four answer options of the *Likert* scale for most of the items. In 31 items, 85% or more of the caregivers responded Never or Almost Never. These items were removed from the questionnaire. Removed items are listed in [Table 2](#).

After removing the items with poor discrimination (i.e., low dispersion of results; [Table 2](#)), we analyzed the homogeneity of the remaining items within each dimension (Cronbach's alpha). All of the dimensions (Dressing/Undressing: $\alpha = 0.84$; Breastfeeding/Feeding/Meals: $\alpha = 0.78$; Bathing Time/Hygiene Activities: $\alpha = 0.81$; Getting Ready to Go Out/Travelling/Community: $\alpha = 0.75$; Playing: $\alpha = 0.87$; Waking/Nap/Bedtime: $\alpha = 0.60$; Diaper Change/Sphincters Control: $\alpha = 0.60$) showed an acceptable internal consistency ($\alpha \geq 0.60$) (Cappelleri et al., 2014).

However, considering the results according to the ages of the children, we found that the SIIRQ is not sensitive relative to the age group from 4 to 8 months, since, in several dimensions, such as "Dressing/Undressing," "Diaper Changing/Sphincters Control," "Breastfeeding/Feeding/Meal" and "Getting Ready to Go Out/Community," a significant percentage of caregivers checked the option "Not applicable." Considering these results, we chose to readjust the age group of the children targeted for evaluation with the SIIRQ to children between 8 and 24 months. We consider this aspect to be preponderant, because, according to Oliveira (2009), key ages of early identification are considered during routine consultations at 9, 18, and 24 or 30 months.

Discussion

This study proposes a new tool, the SIIRQ, for identifying sensory integration vulnerabilities that can affect many areas in the child's life and, consequently, the family's dynamics and routines. The questionnaire is consistent with Ayres Sensory Integration Theory (Ayres, 1969, 1971, 1972) and the model for young children proposed by Smith-Roley et al. (2016). ASI theory suggests that processing and integration of sensory information is a critical neurobehavioral process that strongly influences children's development. Thus, the SIIRQ seeks to identify early possible vulnerabilities of Sensory Integration for early referral and intervention, in order to respond to the concerns and priorities of families, favoring the natural contexts of the child within daily routines.

We also considered the relevance of the items of the various dimensions of the SIIRQ. Lam, Hiscock, and Wake (2003) highlight the importance of identifying early sleeping problems, since sleeping difficulties in children between 6 and 12 months anticipate sleeping and behavioral problems at 3 and 4 years of age. Vasak, Williamson, Garden, and Zwicker (2015) found that babies and children with sensory reactivity issues need a longer time to fall asleep and have a greater number of nocturnal awakenings. Thus, we consider that the dimension Waking up/Nap/Bedtime is extremely important, because caregivers reported that children manifested vulnerabilities in sleep, namely, "He/she needs long periods to fall asleep," "He/she requires physical contact of the adult to remain in the crib sleeping," "He/she needs rhythmic movements to fall asleep." In turn, recent studies suggest that tactile and vestibular hyperreactivity are preponderant to explain sleep problems exhibited by children with typical development (Foitzik & Brown, 2018; Romeo et al., 2021; Vasak et al., 2015; Zakorchemny & Lashno, 2019). Thus, items such as

“He/she is annoyed by the texture of certain fabrics” and *“He/she is annoyed/irritated by the rhythmic movement to fall asleep”* are extremely important items to analyze this dimension.

In the dimension “Diaper Changing/Sphincters Control,” some caregivers have expressed some lack of information on this topic. However, according to recent investigations, vulnerabilities related to sensory reactivity to diaper changing and toileting include behaviors such as expressing pain with defecation, even when feces are normal in size and consistency, resistance on the part of the child to cleaning after defecation, aversion to the smells of feces (Beaudry-Bellefeuille, Booth, & Lane, 2017; Beaudry-Bellefeuille, Lane, & Ramos-Polo, 2016). Beaudry-Bellefeuille et al. (2019) describe behaviors of hyperreactivity to touch or to odors as possible factors that interfere with involvement in activities inherent to bowel functions. Thus, items such as *“He/she seems to feel pain at the time of defecation, including when the feces are soft,”* *“He/she manifests aversion to the smell of feces,”* *“He/she is irritated when cleaning is performed at the time of diaper changing,”* assume relevance in identifying vulnerabilities in sensory integration.

In dimensions such as “Diaper Changing/Sphincters Control,” “Dressing/Undressing,” “Bathing Time/Hygiene Activities,” “Playing,” we highlight the behavior of the child toward changes in posture, in head movement against gravity, since reactivity issues related to vestibular input manifests as excessive emotional reactions. Several authors have highlighted behaviors linked to sensory hyperreactivity such as the child’s overreaction to an adult’s physical contact during playtime; thus, we tried to transpose these vulnerabilities into the dimension “Playing” (Nielsen, Brandt, la Cour, & Siu, 2021; Watts et al., 2014). Children with sensory hyperreactivity (tactile, visual, auditory) may also manifest resistance behaviors toward certain toys (Critz, Blake, & Nogueira, 2015). Additionally, efforts were made to include behaviors common to children with sensory hyporeactivity and poor sensory perception in the various dimensions of the questionnaire, such as: *“He/she retains food in his/her mouth without swallowing it,”* *“He/she seeks extreme sensations, even those that are painful,”* *“He/she does not seem to hear certain sounds”*.

Difficulties in motor planning and difficulties participating in activities of daily living (hygiene, playing, dressing/undressing, feeding) are common in children with sensory integration dysfunction, and were represented in various dimensions, such as *“He/she presents difficulties in the imitation of gestures and facial expressions”*, *“He/she gets angry/cries in activity transitions”*, *“He/she refuses to eat alone/needs help”*. Overall, vulnerabilities in sensory integration can be observed through extreme avoidance of activities, agitation, fear, as well as disinterest toward people and objects (Flanagan et al., 2019).

Some items that lacked adequate spread of responses across the Likert scale, could have been potentially useful in identifying children with sensory integration disorders, however, we decided to eliminate them, to reduce the length of the questionnaire and, consequently, ensure greater adherence by caregivers in filling it out.

Limitations and Future Research

The present study had some limitations. There is a scarcity of assessment instruments for children aged between 4 and 24 months in the context of sensory processing, which makes it difficult to compare the results we obtained with the results of other studies. Moreover, the sample size ($n = 73$) was relatively small. This study was conducted during the COVID pandemic, and specific sampling methods considering geographical distribution and socioeconomic status was therefore difficult to carry out. We therefore opted for a convenience sample and we

are aware that some sociocultural groups may be underrepresented. This procedure does not ensure the generalization of the results to all families living in Portugal and this will need to be considered in future research.

Furthermore, future research will be aimed at obtaining Portuguese normative data of children with typical development, without sensory integration disorders, as well as discriminative validity studies with children with known developmental and/or sensory integration issues. Factor analysis and Rasch analysis will also need to be completed to confirm dimensionality and factor structure of the 102 items which is currently based exclusively on peer review of experts. This needs to be formally tested.

Conclusion

An adequate assessment of sensory integration concerns is extremely important to determine the need for referral and for selecting appropriate interventions. Thus, quick, and clear early screening tools, predictive of developmental concerns, must be put at the disposal of health and education providers to ensure early identification of sensory integration concerns. Thus, with this study, we put forth the preliminary qualitative and quantitative analyses that were used in the construction of the SIIRQ. The set of phases and successive qualitative and quantitative analyses of the instrument led us to the establishment of the experimental version of the

Table 3. Some of the items that are part of the SIIRQ.

Dimension	Items
Waking up	Slow to wake up (e.g., lethargic, silent behavior, takes a long time to become very active)
Nap	Needs long periods of time to fall asleep (e.g., falling asleep more than 30 minutes after bedtime)
Sleeping	Needs continuous rhythmic movement to fall asleep (e.g., car ride, walks while being carried, rocking)
Diaper	Has a negative/exaggerated reaction just before nappy changing (e.g., throws tantrums, cries, resists)
Changing	Shows a high level of tolerance for dirty nappies (e.g., does not complain, cry, show discomfort, continues to do activities)
Sphincter Control	Becomes annoyed/irritated when cleaned during a nappy change (e.g., use of wipes, cream, ointment)
Dressing	Negative/exaggerated reaction to different textures in clothing (e.g., labels, elastics, seams, prefers specific fabrics)
Undressing	Very restless when dressing/undressing (e.g., flailing their arms and legs, pulls away, "runs away" from the adult)
	Passive posture during dressing/undressing (e.g., does not cooperate: does not offer the arm to put it in the sleeve)
Breastfeeding	Negative reaction when hands, face or clothes are dirty (e.g., needs to be cleaned immediately, cries)
Feeding	Avoids touching food with their hands (e.g., raw, sticky, wet food)
Meals	Negative reaction/resistant to changes in textures during the introduction of new foods (e.g., transition from liquids to soft purees, textured purees, soft solid foods requiring chewing . . .)
Bathing Time	Negative reaction/anxious/afraid when moving or having their head moved while bathing (e.g., tilting head back, forward)
Hygiene	Negative reaction to their body being touched (e.g., putting on shower gel, body cream, drying with a towel, splashing)
	Takes excessive pleasure in repeatedly rubbing their body with the sponge
Getting Ready to Go Out	Becomes annoyed/cries in crowded situations (e.g., health center waiting rooms, family parties, shopping, supermarkets)
Travelling	Becomes distressed/irritated when exposed to very bright light (e.g., sunlight through car windows, shop windows in shopping)
Community	Becomes irritated/angry at very loud or unexpected sounds (e.g., motorcycles revving, dogs barking, sirens, alarms)
Playing	Takes excessive pleasure in physical activity and intense movements (e.g.: rocking, bounced on the knee, being lifted up into the air . . .)
	Negative/exaggerated reactions in games involving the caregiver's touch (e.g., does not like to be hugged or touched by the parents)
	Uses too much force when playing with objects (e.g., hitting musical instruments, smashing toys against each other)

questionnaire that will be applied in mainland Portugal, in view of the studies of sensitivity, accuracy and validity, as well as the setting of cutoff points or other parameters of clinical-educational interpretation of the results.

The final experimental version of the questionnaire in Portuguese, aimed at children aged between 8 and 24 months, includes 102 items compatible with ASI® theory and distributed over 7 dimensions of daily routines (McWilliam, 2010). Some of the items that are part of the SIIRQ are listed in Table 3.

The items are evaluated according to a Likert scale, with four answer options. The instructions call for the answer that best describes how often the child performs or manifests the described behaviors. In the main form of the experimental version of the questionnaire, the following elements are registered: child's date of birth, gender, prematurity, father's and mother's age, degree of kinship of the respondent of the questionnaire, father's and mother's educational qualifications and their occupations. Additionally, we hope that the SIIRQ can be used by parents, health professionals (e.g., nurses, family doctors, pediatricians, among others), and education professionals (e.g., educators) who deal with children on a daily basis. We consider that the early identification of possible development vulnerabilities is the responsibility of all primary care professionals who carry out child health consultations, including outpatient pediatricians, as well as educators who have privileged contact with children and families. Early identification allows for referral for a comprehensive and detailed evaluation within the scope of Ayres Sensory Integration by an occupational therapist with advanced training in ASI. The SIIRQ can potentially facilitate this important identification and referral process.

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Author contributions

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