Pretend Play and Executive Function in Preschool-Aged Children with an Acquired Brain Injury

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The authors compare pretend play and executive function both in preschool children with an acquired brain injury and in neurotypical preschool children. They find the ability to produce logical, sequenced pretend play actions and object substitutions in play correlates strongly with executive function ability in both groups, and working memory emerges in their study as the most reliable predictor of pretend play in both groups of children. Their investigation highlights the need to include pretend play in rehabilitating children with brain injuries and the importance of pretend play for developing executive function in all children. **Key words**: acquired brain injury; executive function; pretend play; rehabilitation for children.

Background

Kids Rehab at The Children's Hospital at Westmead is the largest pediatric multi-disciplinary rehabilitation team in Australia. As part of this program, children with an acquired brain injury (ABI) attend the Brain Injury Clinic at regular intervals to be assessed and to receive therapeutic intervention. Approximately 10 percent of the children with an ABI in Kids Rehab are preschool aged. Through clinical involvement with these children, we discovered many could perform developmentally appropriate structured tasks but were unable to produce age-appropriate spontaneous pretend play.

There is emerging evidence that children with ABI have difficulty producing age-appropriate pretend play (Dooley, Stagnitti, and Galvin 2019; Thorne, Stagnitti, and Parson 2021). Pretend play requires complex cognitive abilities (Francis and Gibson 2023; Wah 2020) such as the inhibition of reality (Vygotsky 2016), the use of symbols, the remembering of roles, and then the skill of add-

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ing to the construct in play with others (Rakoczy 2006; Russ 2014; Stagnitti 2017). These abilities appear congruent with executive function, in particular with inhibition and working memory (Carlson, White, and Davis-Unger 2014; Thibodeau et al. 2016). The literature addressing cognitive deficits in children with an ABI reports the pervasive presence of deficits in executive function (Anderson et al. 2010; Crowe et al. 2013). To broaden our understanding of the relationship between pretend play and executive function we assessed these abilities in children with an ABI and in their neurotypical peers. We did so to detail the difficulties faced by children with an ABI and the possible opportunities for improved outcomes through rehabilitation.

Acquired Brain Injury

Acquired Brain Injury refers to any damage to the brain that occurrs after birth. Causes of ABI include traumatic injury, stroke, brain tumor, cerebral anoxia, or encephalitis (Chevignard et al. 2010; Ilmer et al. 2016; McKinlay et al. 2016). ABI is recognized as a major disability group by the Australian government (Australian Institute of Health and Welfare) (AIHW 2007). The Australian government's Bureau of Statistics 2018 Survey of Disability, Ageing, and Carers, revealed that there are in Australia about twenty thousand children under the age of fifteen (approximately 0.5 percent of all children) with an ABI.

Children who sustain an ABI are likely to have persistent long-term disability (AIHW 2007) across a wide range of developmental areas (Ilmer et al. 2016; O'Keeffe et al. 2017; Rivara et al. 2011). Specifically, these developmental areas include fine motor skills, gross motor skills (Recla et al. 2019), social skills (Ryan et al. 2016), cognitive abilities (Anderson et al. 2011; Recla et al. 2019), and play skills (Dooley, Stagnitti, and Galvin 2019; Thorne, Stagnitti, and Parson 2021). In these areas, children with an ABI seem most persistently to experience long-lasting cognitive difficulties (Anderson et al. 2010; Anderson et al. 2011).

Pretend Play

Pretend play is a complex cognitive and socio-emotional activity in which children explore materials and ideas in depth, inhibiting reality, understanding the intention of play, and imposing their own meaning on what they are doing (Rakoczy 2006; Russ 2014; Stagnitti 2021). It "is a signature behaviour of early childhood" (Lillard 2017), the central occupation of young children (Stagnitti and Unsworth 2000) and the dominant form of play in the preschool years (Vygotsky 2016). It is evident across all cultures (Gaskins 2013). Pretend play emerges at approximately twelve months of age, and continues to develop rapidly through early childhood. It reaches its pinnacle in the late preschool years, (Lillard 2017), with the ability of children to play a story narrative over several days, using complex problem solving, creating props needed in the play, and embedding characters and roles (Stagnitti 2021). Wah (2020) describes pretend play as a uniquely human trait requiring the higher cognitive abilities of a complex working memory, imagination, and metacognition.

The pretend play of children with an ABI has not attracted much discussion in the literature, however. In their respective studies, Fink, Stagnitti, and Galvin (2012), Dooley, Stagnitti, and Galvin (2019), and Thorne, Stagnitti, and Parson (2021) found evidence that children with an ABI had deficits in their pretend play ability. Dooley, Stagnitti, and Galvin studied twenty-six children ranging in age from three to seven years; Fink, Stagnitti, and Galvin, three children aged three to six years; and Thorne, Stagnitti, and Parson, twenty-one children three to six years of age, all having an ABI. All three studies found that, when assessed with the Child Initiated Pretend Play Assessment (ChIPPA) (Stagnitti 2007, 2022), the children had significant difficulty producing sequenced actions of pretend play compared to the normative sample (Fink, Stagnitti, and Galvin 2012; Dooley Stagnitti, and Galvin 2019) or a control group of aged peers (Thorne, Stagnitti, and Parson 2021). These studies described the children's play as disjointed and disorganized, particularly play with unstructured play materials. The studies likewise reported the children's ability to substitute objects in the play to be significantly below age expectations. All studies reported a significant portion of children unable to sustain their play for the time required in the assessment. This reduced capacity to produce developmentally appropriate pretend play or to sustain play placed children with an ABI at risk of losing the developmental benefits of engagement in pretend play (Thorne, Stagnitti, and Parson 2021).

Executive Function

Executive function is a psychological construct (Anderson 2008) best understood as made up of a number of components separate from but related to cognitive function. These components are needed when attention and concentration are required to exhibit conscious control over thought, action, and emotion (Carlson and White 2013; Lee and Carlson 2015). These abilities allow individuals to adapt to the external demands of an environment or task and not simply to rely on the information they have already retained (Horton, Soper, and Reynolds 2010). The core components of executive function are generally agreed to be working memory, inhibition, and cognitive flexibility or set shifting (Diamond 2013; Fuglestad et al. 2015; Garon, Smith, and Bryson 2014; Lerner and Lonigan 2014). Skogan and her associates (Skogan et al. 2016) add to these the abilities to plan and organize.

Emergent executive function can be seen in early infancy, in which attention serves as the foundation (Garon, Bryson, and Smith 2008). There is then an acceleration of development through the preschool years (Carlson and White 2013; Garon, Bryson, and Smith 2008; Lee and Carlson 2015). Some evidence exists that at three years of age, executive ability is difficult to separate into discrete domains, functioning more as a general ability, with working memory appearing first followed by inhibition and then shifting, after which all domains become apparent by the age of seven (Wiebe et al. 2011).

Children with an ABI appear to be at risk for executive function deficits throughout childhood in comparison to their neurotypical peers (Crowe et al. 2013; Anderson et al. 2010). Crowe and his colleagues (Crowe et al. 2013) found that on a direct assessment of children aged three to six, the children with moderate (n=19) and severe (n=16) traumatic brain injury (TBI) had attention control difficulties, in particular with inhibition, compared to their typically developing peers (n=20). No parent-reported difference, however, was found using the Behavior Rating Inventory of Executive Function—Preschool edition (BRIEF-P) (Gioia, Espy, and Isquith. 2003).

Krasny-Pacini and others (Krasny-Pacini et al. 2017) assessed executive function in children three, twelve, and twenty-four months post severe traumatic brain injury (TBI, n=66). They reported significant impairment in working memory and the "global executive composite," but not shift or cognitive flexibility, on the parent-reported questionnaire, (BRIEF-P) (Gioia, Epsy, and Isquith 2003). On direct measures of executive function, at twelve and twenty-four months after injury the children showed no significant difference from the assessment norms, using direct or parent-report measures.

Children seven years after severe TBI (n=27) underwent assessment of their executive function via a parent questionnaire (BRIEF) and computerized tasks (Le Fur et al. 2020). This study revealed significantly more deficits in executive function, including working memory, when compared to a group of age- and sex-matched peers. No deficits in cognitive flexibility, however, were found.

Pretend Play and Executive Function

Lillard and her colleagues (Lillard et al. 2013), in their review of the literature citing the impact of pretend play on childhood development, found the evidence inconclusive that pretend play assists executive-function development. Of the fourteen studies they reviewed that specifically addressed executive function and emotional regulation, they reported discovering limited correlational findings and described the intervention studies as inconclusive, leading them to declare the "evidence that pretend play assists executive function is sparse at best"(23).

Lillard and her coauthors were critical of the methodologies used in many of the studies, including a lack of children engaging spontaneously in pretend play. Carlson, White, and Davis-Unger (2014) and Kelly and her colleagues (Kelly et al. 2011), both studies cited by Lillard, reported a correlation between pretense and inhibition in typically developing preschoolers. The pretense measures used in both studies did not require the children to generate pretend play but relied heavily on modelling by the examiner and the child identifying what the examiner was pretending. Lillard and her colleagues contest that this type of knowledge test relies on executive function. Carlson, White, and Davis-Unger (2014) remarked that their study was limited because the children did not engage in pretend play itself, which meant they were unable to make clearer the relationship between actual pretend play and executive function.

Berk and Meyers (2013) refuted the proposition of Lillard and her coauthors that adult influence could explain observed associations between pretend play and executive function. The former argued instead that spontaneous pretend play occurs in the context of peers not adults and that adults directing children in pretend play scenarios results in less pretense from children. Nicolopoulou and associates (Nicolopoulou et al. 2010) reported that excessively scripted classroom play corners created by teachers have limited benefits because they offer only limited scope for children to express their own initiatives in play. More time spent in unstructured free play at a preschool predicted self-regulation two years later (Colliver et al. 2022), and pretend play in early childhood predicted self-control up to three years later (Berk and Meyers 2013). Pretend play ability in at-risk, preschool-aged children was found to protect the executive function development in their first year at school (Thibodeau-Nielsen et al. 2020).

Lillard (2017) also proposed that pretending in childhood does appear important to human development. She based her assertion on a comparison between the pretend play of young children and the importance of young animals pretend fighting because this pretending allowed these animals to hone the hunting skills essential for their survival. Other researchers have concluded that play fighting in young animals promotes social and emotional development and makes for more adaptable adults (Pellis and Pellis 2017). Pellis and Pellis go on to argue that play fighting provides training for psychological resilience because the monitoring and contextual adjustment to another during play fighting influences the development of executive functions.

In a study examining the cognitive processes of imaginary representations, Francis and Gibson (2023) measured counterfactual reasoning, pretend play, and executive function in 189 typically developing four- to five-year-old children. They found that the latent constructs of pretend play and counterfactual reasoning were correlated ($r = .51$, $p < .001$) and that complex executive functions (EFs) "accounted for significant unique variance in pretend play (ß = 21) and counterfactual reasoning (ß = 22) over and above age and receptive language, but working memory did not" (17). From their findings, Francis and Gibson argued that the measure of complex EF in their study could be described as a general measure of EF and, if treated as a broad unitary construct for preschoolers, then EF was integral to pretend play.

Thibodeau and her associates (Thibodeau et al. 2016) found that preschool-aged children who were highly engaged in a pretend play fantasy story-making intervention showed greater improvements in their executive function ability than children in a nonpretend play intervention group. Likewise, Esmaili and her colleagues (Esmaili et al. 2019) found that, in their investigation with older children (seven to eleven years) with diagnosis of specific learning disorder, a play-based intervention had a positive impact on the children's scores on a parent-rated measure of executive function (BRIEF). White and her coauthors (White et al. 2021) reported that preschool children engaged in child-initiated, social pretend play showed improvement in inhibition compared to other forms of play.

Qu and associates (Qu et al. 2015), however, found that sociodramatic play did not predict working memory on a backward digit span task. Object substitution ability did not predict inhibition in preschoolers (Hopkins et al. 2016) or executive function in children with autism (Faja et al. 2016). In both studies, however, the substituted object was provided to the children, not generated by them, and the target behavior was a single symbolic play action with this object, not the child's engagement in pretend play.

The emerging literature suggests that the relationship between pretend play and executive function is complex. Complex executive function, as measured by working memory, inhibition, and cognitive flexibility in Francis and Gibson's (2023) study, did account for significant unique variance in pretend play ability when pretend play was measured by observing children's elaborate play actions and object substitution in self-initiated play. Hopkins and associates (Hopkins et al. 2016) suggested that the development of executive function and pretend play is likely interdependent, with one being built upon the development of the other. In some studies (Hopkins et al. 2016; Qu et al. 2015; Faja et al. 2016), the use of a simple pretense task examined children's knowledge of pretend play, not their self-initiations of their own ideas in play. We argue that a measure such as children's knowledge of pretend play does not constitute engagement in self-initiated, pretend play ideas and that the former may not have exposed the depth of the relationship between pretend play ability and executive function. For example, the elaborate sequence of self-initiated play actions needed to create a story was not captured in these studies, and such an ability to elaborate may affect executive function through working memory. Perhaps child initiation of the play is an important factor linked with executive function, as found in studies such as Francis and Gibson (2023), Thibodeau et al. (2016), and Esmaili et al. (2019). Shaheen (2014) concluded that play-based approaches to improve executive function in children appeared to hold the most promise and recommended that further research was required.

Children with an ABI have reported difficulties in both executive function and pretend play. If, as the literature suggests, an interdependence exists in the development of these abilities, children with an ABI are at an increased risk of further disruption to their development should both areas not be addressed. A greater understanding of the relationship between these abilities in children with an ABI is important to guide rehabilitation intervention.

The first aim of this study was to investigate the relationship between pretend play and executive function ability in preschool-aged children (between three and six years) with an ABI and in neurotypical children. The second aim was to investigate what aspects of executive function ability could best predict pretend play ability to guide recommendations for rehabilitation intervention for children with an ABI.

Method

The study was a nonexperimental group comparison. We obtained ethics approval from both Deakin University and the Sydney Children's Hospital Network, approval number HREC/18/SCHN/234. We gained verbal consent from the children prior to the assessment; we told the children that the researcher wanted to see how they play. We gained written consent from parents for their children's participation in the study.

Participants

Children with an ABI were eligible for recruitment to the study if they had a moderate or severe ABI, were aged between three and six years (had not yet started school), and had been discharged from inpatient subacute rehabilitation. The exclusion criteria included children described in the medical records as having profound cognitive or physical impairment that would preclude their ability to initiate interaction with the play materials. Children with uncontrolled seizures and children who had a preexisting diagnosis of autism, ADHD, developmental delay, or did not speak English were excluded because they may have confounded the results.

We identified twenty-nine preschool-aged children with ABI who fit the criterion and invited them to participate. Three did not respond, and we could not contact them. Twenty-six agreed to participate. Due to logistical reasons, we could not complete five assessments, leaving twenty-one participants. We recruited twenty-two neurotypical children and obtained their parents' consent. All this provided a total sample of forty-three children for the study.

We chose the sample size based primarily on practical considerations, including the number of preschool-aged children attending Kids Rehab over a two-year period. We also asked the parents who identified as primary care givers for each child in the study to complete the parent questionnaire. Twenty-two questionnaires from the neurotypical group were returned, as were seventeen from the group of children with an ABI.

The twenty-two neurotypical participants in the study included children recruited through contact with preschool and day care centers in western Sydney and those of staff members of Kids Rehab. Children were eligible for recruitment to the study in the neurotypical cohort if they were aged between three and six years (and had not yet started school). Exclusion criteria included learning and behavioral or other difficulties as identified by parents or preschool staff and children who had previously seen a therapist as reported by parents or teachers. We also considered ineligible for inclusion in the study children in the typically developing cohort who performed below the cut off for typical development (two months or more below age expectations) on the language or cognitive subtests of the Australian Developmental Screening Test (ADST) (Burdon 1993). We made this decision based on the assumption that pretend play involves cognitive ability and is robustly related to language (Francis and Gibson 2023; Quinn et al. 2018).

Measurements

We used the Child Initiated Pretend Play Assessment (ChIPPA) (Stagnitti 2007, 2022) to assess the pretend play abilities of the children. This assessment is a standardized normative referenced assessment for children aged three to seven years. The norm sample comprises 693 children. It assesses the quality of a child's ability to intiate pretend play spontaneously and to sustain it over eighteen minutes (for three-year-olds) or thirty minutes (for four- to seven-year-olds) (Stagnitti 2022). This became the preferred play assessment for this study of child-initiated sequenced actions of pretend play and child-initiated object substitution in a standardized format.

The ChIPPA is comprised of two sessions, a Conventional-Imaginative Play session and a Symbolic Play session. The conventional toys include a combination of farm animal figures, dolls, fences, cups, spoon and plates, and a wrench, depending on children's ages. The symbolic toys consist of boxes, tins, sticks, pebbles, tea towels, wash clothes, and two dolls made from cloth. The ChIPPA is administered sitting on the floor with the child, in front of a play space created by placing a sheet over two adult chairs (cubby house). The children are invited to play whatever they would like with the toys. In the central segment of play in both sessions, the examiners model five play actions with the toys or unstructured objects, but only if they have access to the play materials and the children's play is not disrupted. All actions made by the children are recorded and coded as functional play, elaborate pretend play, behavioral action, repeated actions, or imitated action (the latter occurring in the central segment only). Elaborate pretend play actions also included attributions of properties and references to absent objects. The percentage of elaborate play actions (PEPA) score is calculated by the number of elaborate pretend play actions divided by total play actions times one hundred. The Object Substitution (NOS) score counts the number of times a child uses a toy or object in the play as something other than what it is. Such scores are then converted to a standard score. The number of imitated actions (NIA) score counts the number of times a child copies the modelled action of the assessor within three play actions of the action being modelled. Gender differences have been found and separate normative tables provided.

The assessment also provides for structured observations of the children's play (the Clinical Observations Form) including play themes and narrative production. In addition to the ChIPPA scores, this study also calculated the number of times children required a verbal prompt to return to the play area or continue to play because they had stopped playing. A typical pattern of play on the ChIPPA lies within expected range or higher scores in elaborate play actions (PEPA) and object substitutions (NOS) and none-to-one imitated action (NIA). This pattern occurs in play when children can initiate play and do not need assistance for ideas to play.

The ChIPPA has been shown to have good inter-rater reliability using the Kappa statistic, *k)* of *k*=0.7, (Swindells and Stagnitti 2006) and .87–.96 for ICCs (Francis and Gibson 2023). Test-retest reliability was stable with ICCs (2,1) ranging from .73 (PEPA conventional) to .83 (PEPA combined) (Stagnitti and Unsworth 2004). The PEPA combined and NOS combined scores have been shown to discriminate between preschool children with preacademic problems and typically developing preschoolers with a discriminative function $X^2 = 47.6$, $p< .001$ (Stagnitti, Unsworth, and Rodger 2000). The ChIPPA has concurrent validity with positive moderate, significant correlations between all PEPA scores and the Pen Interactive Peer Play Scale (PIPPS) (Fantuzzo and Hampton 2000; Uren and Stagnitti 2009). Social interaction scores were moderately and significantly related to PEPA conventional (r= 0.430, $p < 0.1$), PEPA symbolic (r = 0.272, $p < 0.05$), PEPA combined (r = 0.356, $p < 0.01$), indicating that children who scored within expected range and above on the ChIPPA were rated by teachers as socially interactive. Significant negative correlations between NOS symbolic and PIPPs play disruption score, (r = - 0.336, p< 0.01) indicated that children who could not spontaneously substitute objects were rated by teachers as socially disruptive (Uren and Stagnitti 2009). For predictive validity over a four-year period, Stagnitti and Lewis (2015) found a significant correlation between the PEPA combined scores at preschool with sematic organization at age eight and nine years as measured on The School Age Oral Language Assessment (Allen, Donovan, and Leitao 1993)(r =0.43, p= 0.001).

We completed direct assessment of the children's executive function using the Preschool Executive Function Battery (PEFB) (Garon, Smith, and Bryson 2014). We chose this assessment because it provides tasks for the assessment of both simple and complex executive function abilities, which give the tasks greater sensitivity. We saw this as an advantage when assessing children with an ABI. The measures proved to have no gender differences. The working memory task used a sequence of boxes with an increasing number of doors. Using one box at a time, the target toys were hidden one at a time behind the assigned door, and the children were asked to recall in sequence which door the toys were hiding behind. The inhibition task used two boxes with two see-through doors, and the children needed to inhibit their impulse to open the door directly and instead use a lever to open the door to release the target toy. The second box had a contralateral opening lever, increasing the difficulty of the task. The set-shifting task used a flip-book, and the children followed an initial rule of color or shape to find a hiding animal figure. Then the rule changed, and the children again had to find the hiding figure.

The measures were shown to have adequate to good internal reliability (0.7-0.93) using Cronbach's alpha. Garon, Smith, and Bryson (2014) compared the results of the battery with other studies using similar executive function tests and found construct validity with previous research, that is, similar percentages of variance accounted for by the ages of the participants, displaying the sensitivity of the battery to age.

Garon, Piccinin, and Smith (2016) found the PEFB to have significant association with the Behavior Rating Inventory Executive Function-Preschool Version (BRIEF-P). They reported decreased sensitivity to age of the working memory component of the PEFB, with many four-year-olds approaching the ceiling. Boudreau and coauthors (Boudreau et al. (2017) expanded the working memory task of the PEFB by modifying the original task designed to increase the difficulty of the retrieval and substitution elements of the task by increasing the number of boxes with more doors and more toys to find. The modified working memory task was found to have significant association with teacher-rated scores on the BRIEF-P.

We used the Behavior Rating Inventory of Executive Function—Preschool version (BRIEF-P) (Gioia et al. 2003) because it is the only standardized assessment that provides information about preschool-aged children's executive function behavior in their everyday environments as observed by their parents. The BRIEF-P is a standardized normative referenced sixty-three–item questionnaire that parents use to rate when, during everyday activities, a child's executive function behavior is a problem (Gioia et al. 2003). The children are rated on a three-point scale: never (1), sometimes (2), or often (3). A child's given behavior is rated in response to particular scenarios, for example, "Forgets what he/she is doing in the middle of an activity" or "Overacts to small problems" (Skogan et al. 2016). A higher score indicates more difficulty with executive function. The scores are divided into five scales and subsequently three broad indexes are formed through the combinations of the scales. Then the inventory generates a Global Executive Composite (GEC). The BRIEF-P is a standardized normative referenced assessment. Significant differences in sex have been found, showing boys generally to rate higher than girls. Separate normative tables are provided (Gioia, Espy, and Isquith 2003).

The BREIF-P has adequate to good internal consistency for all five subscales with Cronbach's alpha values from 0.76 to 0.95 (Skogan et al. 2016). The test-retest reliability coefficient for the GEC was reported as 0.90 for parent ratings (Gioia, Espy, and Isquith 2003). The BRIEF-P trio of indexes showed significant association with the corresponding tasks on the Preschool Executive Function Battery (Garon, Piccinin, and Smith 2016).

To capture a general level of cognitive and language development, we used the cognitive and language domains of the Australian Developmental Screening Test (ADST) (Burdon 1993). We chose this screen because it is play based and easy to administer without detracting from the other assessments. The ADST is a standardized screening of child development from six months. The test is designed to be administered individually to children when there is suspicion of developmental delay. The ADST covers five domains including: personal-social, language, cognitive, fine motor, and gross motor. Preliminary indications of sensitivity and specificity, and discriminative validity studies indicated high

Demographics	ABI	NT	*p* value
Age	M=50.5 SD=11.9	M=52.8 SD= 7.1	0.443
Sex	Female= 48% Male=52%	Female= 73% Male= 27%	.239 .225
ADST % CD	M= 95.2 SD=11.8	M= 100.6 SD=7.2	0.09
ADST % LD	M= 91.8 SD=10.5	M= 100.4 SD=7.6	0.002
Attends preschool	43%	77%	
Age at injury	<18 months 57% >19 months 43%		
Severity of injury	Moderate 38% Severe 62%		
Time since injury	<31 months 38% >31 months 62%		

Note. ABI= acquired brain injury, NT= neurotypical, ADST= Australian Developmental Screening Test, CD= cognitive development, LD= language development, $p<0.05$

Figure 1. Demographic Information of Children with an ABI (n=21) and Neurotypical (n=23)

levels of sensitivity and very acceptable levels of specificity, (r = .875, *p* < 001, two tailed). The ADST is a standardized screening of child development. A score is calculated to give a developmental age in months for the children. We then converted this score to a percentage of individual development for each individual child.

Data Collection and Analysis

Demographic information was recorded (see figure 1), information included injury type, severity, and age at injury for the children with an ABI. The chronological age, cognitive age, and sex distribution of both groups showed no significant difference. There was a significant difference in the language abilities between groups. All direct observation assessments were completed by one of the authors, Adrienne Thorne. She assessed children in a familiar environment, such as a playroom at Kids Rehab, or a quiet space at the children's preschool. We randomly assigned the order of the assessments using a latin square to account for test order fatigue.

The BRIEF-P was completed by the parents or care givers considered by the family units to be the primary care givers of the children. Four parent questionnaires were not returned.

Data Analysis

For the ChIPPA and BRIEF-P, we converted the children's raw scores to standard scores. The expected age range for standard scores for PEPA and NOS combined in the ChIPPA was from -1.0 to +1.0. Both assessments have sex specific normative tables. Although there was no statistically significant difference between the groups on sex, we used these tables to eliminate any sex bias. The PEFB does not have normative data, but Garon, Smith, and Bryson (2014) reported no sex differences in their study.

We used nonparametric statistical techniques to analyze the data because the data did not meet the criteria for a parametric approach. We used a Mann-Whitney U test to determine the likelihood of a difference in the results between the groups. A Spearman's rho was used to determine the correlation matrix between the pretend play and executive function results. We have used the interpretation of Spearman's rho results provided by Dancey and Reidy (2004) as follows: >0.7, very strong; 0.69–0.4 strong; 0.39–0.3, moder-

ChIPPA	ABI		NT		
	Mean	SD	Mean	SD	*p*
PEPA Conventional	-1.66	1.05	-0.36	0.67	.000
PEPA Symbolic	-1.36	0.63	-.08	0.6	.000
PEPA Combined	-1.79	0.82	-0.30	0.59	.000
NOS st/raw	-0.63/7	0.6/7.2	0.21/17	0.71/9.5	.000
NIA combined	1.2	1.7	0.3	0.7	.015
NOP to continue to play	7.1	4.5	2.9	2.2	.000
PEFB EF Total Score	52.5	9.7	68.0	5.4	.000
PEFB WM Total	25	6.7	34.0	4.5	.000
PEFB Inhibition Total	12.8	3.7	14.9	3.7	.013
BRIEF-P GEC	56.2	20.3	45.9	7.7	.011
BRIEF-P Working Memory	62.8	15.6	47.0	8.7	.000
BRIEF-P Inhibit	57.3	15.1	46.0	7.4	.007
BRIEF-P Shift	50.7	12.0	47.9	6.4	.834

Note. ChIPPA= Child Initiated Pretend Play Assessment, PEFB = Preschool Executive Function Battery, BRIEF-P = Behavior Rating Inventory of Executive Function—Preschool, ABI= acquired brain injury, NT= neurotypical, PEPA= Percentage of Elaborate Pretend Play, NOS = Number of Object Substitutions, NIA = Number of Imitated Actions, NOP = number of prompts to continue to play, EF = Executive Function, WM = working memory, *GEC + Global Executive Composite,* st = standard score, raw = raw score

Figure 2. ChIPPA, PEFB and BRIEF-P parent results for children with an ABI (n=21) and neurotypical (n=22) participants

ate; 0.2–0.29, weak; .01–0.19, negligible.

We fitted a Generalized Linear Model to determine the aspects of executive function that would best predict pretend play results. We considered a Generalized Linear Model the most appropriate for the regression analysis because it constitutes a nonparametric approach that identifies relationships between data sets that are not necessarily linear. We used the GLM with the lowest Akaike Information Criterion (AIC), suggesting the model of best fit. This was a Gaussian family with Identity link. This GLM is a normal linear regression analysis.

Results

Our first aim was to investigate the relationship between pretend play and executive function.

The comparison of the two groups revealed the children with an ABI scored significantly lower on the ChIPPA than the neurotypical children for elaborate pretend play actions and object substitution. Children with an ABI imitated significantly more than the neurotypical group, indicating difficulty with self-initiated pretend play. The children with an ABI also scored significantly lower on the PEFB (indicating difficulty with executive function) and significantly higher on the BRIEF-P (higher scores indicating more difficulty in executive function) than the neurotypical group (see figure 2).

The correlation matrixes comparing the ChIPPA results with scores of the parent-reported BRIEF-P and direct measure PEFB are presented in figures 3 and 4. High scores on the BRIEF-P indicate difficulty with executive function. Conversely, lower PEFB scores indicate more difficulty with executive function, and low scores in elaborate play (PEPA) and object substitution (NOS) on the ChIPPA indicate difficulty producing pretend play. The number of imitated actions was not included in the correlation analysis because of the restricted range of scores (Cote et al. 2021).

The main result from the correlational analysis were that children with ABI showed strong to very strong relationships between lower elaborate pretend play ability and difficulties in executive function, both for parent report (figure 3) and direct observation (figure 4). The neurotypical children's pretend play ability of object substitution showed a moderate to strong relationship to executive function, abilities of working memory, inhibition, planning, and

ChIPPA	WMemory ABI/NT	Inhibit ABI/NT	Shift ABI/NT	Emot. Con ABI/NT	Plan/org ABI/NT	BRIEF-P GEC ABI/NT
PEPA Conventional	-.704*/.145	-.374/.202	-.395 .259	-.530*/-0.36	-.425/.186	-.626*/.135
PEPA Symbolic	-.51*/-.229	-.167/-.113	-.413/-.053	-.381/-.225	-.427/-.027	-.449/-.141
PEPA Combined	-.719*/-.039	-.368/.017	-.504*/.099	-.670*/ -.149	-.589*/.077	-.719*/-.002
NOS Combined	-.343/- .627**	-.278/-.411	-.362/-.172	-.293/-.252	-.368/ -.403	-.341/-.523*
NOP	.373 / .431	.256/.384	.157/.089	.320/.393	.310/.57**	.373/ .452*
%lang	-.327/-.05	-.075/ .054	-.705*/-.353	-.307/ .216	-.197/-.119	-.287/-.114
%cog	-.419/-.131	-.344/-.077	-.171/-.361	-.129 /.195	-.248/-.106	-.358/-.09
AGE	.299 /-.12	.31/ .212	.19 / .-.326	.028/.36	.165/.001	.127/ -.012

Note. ABI/NT = Children with Acquired Brain Injury / Neurotypical children
ChIPPA= Child Initiated Pretend Play Assessment, BRIEF-P = Behaviour Rating Inventory of Executive Function-Preschool, EC = emotional control, WMemory = working memory, Plan/org = plan/organize, Inhibit = inhibitory self-control index, Shift = flexibility index, GEC= Global Executive Composite, PEPA= Percentage of Elaborate Pretend Play, NOS = Number of Object Substitutions, NOP = number of prompts to continue to play, %lang = language score, % cog = cognition score, AGE = age in months
*p<0.05, **p<0.01.

Figure 3. Correlation matrix: ChIPPA and BRIEF-P parent scores in children with an ABI (n=17) and neurotypical (n=22)

ChIPPA	WMemory ABI/ NT	Inhibit ABI/ NT	Shift ABI/ NT	EFT ABI/ NT	%lang ABI/ NT	%Cog ABI/ NT	Age in months ABI/ NT
PEPA conventional	.475*/-.22	.173/.183	.052/ .057	.264/ .009	.307/ -.173	.372/-.179	-.023 /-.03
PEPA Symbolic	.231/-.11	.045/.125	.107/-.07	.243/ .008	.283/-.15	.326/-.104	-.03 /-.19
PEPA Combined	.379/ -.096	.198/.25	.077/.052	.391/.092	.319/-.247	.508*/ -.234	-.053 /-.2
NOS Combined	.134/.337	.083/-.19	.055/.32	.22/.145	.546*/ .105	.417/.075	-.047/.005
NOP	-.356/.089	-.354/-.165	-.169/-.52*	-.252/-.103	-.297/-.096	-.074/-.159	-.28 /-.058
%lang	.319/ -09	.135/.118	.142/.069	.159/.193	-	.843*/.96**	.88** /.82**
%Cog	.137/ -.096	.337/.134	-.073/.068	.368/.201	/.964**	-	.89** /.884**

Note. ABI/NT = Children with Acquired Brain Injury / Neurotypical children, ChIPPA = Child Initiated Pretend Play Assessment, PEFB = Preschool Executive Function Battery, WMemory = working memory, EFT = executive function total, PEPA = Percentage of Elaborate Pretend Play, NOS = Number of Object Substitutions, NOP = number of prompts to continue to play, %lang = language score, % cog = cognition score,
*P<0.05, **P<0.01

Figure 4. Correlation ChIPPA and PEFB Scores: Children with an ABI (n=21)/ neurotypical (n=22)

organization and global score on the BRIEF-P.

For children with ABI, lower scores in elaborate play (indicating difficulty sequencing elaborate pretend play) were significantly strongly to very strongly negatively correlated with all subtests of the BRIEF-P except inhibit. This indicates that parents rated their child with difficulties in executive function and these children also produced less elaborate sequenced play actions (see figures 2 and 3).

The working-memory scale of the BRIEF-P had strong to very strong significant negative correlations with all three PEPA scores for the group of children with an ABI (indicating difficulty in working memory and lower ability in elaborate pretend play) (see figures 2 and 3). The PEFB working-memory task also had a strong significant positive correlation with PEPA conventional for the children with an ABI, indicating lower scores in executive function working memory and play (see figures 2 and 4). Low scores in sequenced actions of elaborate pretend play (PEPA) were significantly related to difficulties in working memory, planning and organizing, cognitive flexibility (shift), emotional control, and the global composite score for executive function for children with an ABI (see figures 3 and 4).

For the neurotypical group, the working-memory scale and GEC of the BRIEF-P had a strong, significant negative correlation with the object substitution ability in pretend play. There were also moderate relationships between object substitution ability and the inhibit and plan-or-organize scales. This indicates that ability in object substitution on the ChIPPA (high scores) was strongly related to parents' ratings of children's ability in executive function (low scores) (see figures 2 and 3). Neurotypical children also needed fewer prompts to continue to play, and this showed strong, positive, and significant relationships between the executive function ability of planning and organizing and global scores in executive function (that is, low scores also from parents) (see figures 2 and 3).

General cognitive development did not significantly correlate with the BRIEF-P working-memory scale or GEC for children with an ABI or the neurotypical group (working memory: $p = .094$; $p =.345$ respectively), (GEC $p = .157$, $p =.067$ respectively). Language development showed a strong positive significant relationship with NOS for children with an ABI, indicating low scores in both.

Our second aim was to investigate what aspects of executive function ability could best predict pretend play ability.

Simple regression models | Multiple regression models

PEPA-Com	Constant	Coefficient	*P*-value	95% CI	R2	Constant	Coefficient	*P*- value	95% CI	Adjusted R squared
BRIEF-P WM	.559	-.036	< .001	0.58, -.019	.54	.767	-.031	.061	-.064, .002	.45
BRIEF-P EM	-.123	-.033	.016	-.059, -.007	.33		-.006	.696	-.04, .027	
BRIEF-P PO	.349	-.038	.012	-.067, -.009	.35		-.006	.756	-.046, .034	
BRIEF-P Shift	-.336	-.03	.076	-.063, .004	.20					
BRIEF-P WM						-2.84	-.03	.004	-.049, -.011	
Cog %							.03	.042	.001, .059	.61
GEC	.02	-.032	.009	-.055, -.009	.37	-3.98	-.023	.036	-.045, -.002	.49
Cog %	-6.54	.049	.008	.015, .082	.39		.036	.028	.004, .068	

Note: BRIEF-P = Behavior Rating Inventory of Executive Function-Preschool, BRIEF-P WM = working memory score from the parent report, EM = Emotional control, PO = Planning and organising, Cog% = cognition score from the Australian Denver Developmental Screen, GEC = Global Composite Score

Figure 5. Regression models for PEPA combined score of children with an ABI (n =17)

Simple regression model

	Constant	coefficient	*P*-value	95% CI	R2
BRIEF-P WM	2.05	-.039	.022	-.072, -.006	.23
BRIEF-P GEC	2.07	-.041	.038	-.079, -.002	.20

Note: BRIEF-P = Behaviour Rating Inventory of Executive Function- Preschool, WM = working memory score from the parent report, GEC = global composite score from the parent report. NOS = Number of Object Substitutions from the Child-Initiated Pretend Play Assessment

Figure 6. Regression for number of objects substitutions (NOS) and executive function for the neurotypical group (n =22)

We investigated the executive function scales that had a significant relationship with the PEPA combined scores of the ChIPPA along with general cognitive development using both simple regression models and a multiple regression model (see figure 5).

The multiple regression results indicated working memory (*p* = .005) and general cognition (*p* = .04) combine to produce the model that best predicts the PEPA combined scores of children with an ABI. The regression equation (PEPA combined = -2.84 - 0.03 X working-memory score + 0.03 X general cognition percentage) showed that PEPA combined standard score will decrease .03 for every point increase in the BRIEF-P working-memory scale (that is, when working-memory ability decreases, as reported by parents, there is a corresponding decrease in pretend-play ability). PEPA will increase .03 for every percentage point increase in general cognitive development. The equation is a strong predictor of PEPA combined with an $R^2 = 0.66$ (that is, the equation predicts 66 percent of the variation in PEPA combined scores).

We examined The GEC separately because it is an aggregate score and is not independent of the other scale scores. The regression equation (PEPA combined = .02–0.03 X GEC score) indicated the PEPA combined standard score will decrease .03 for every point increase in the BRIEF-P GEC. The equation is a moderate predictor of PEPA combined score with an $R^2 = 0.37$ (that is, the equation predicts 37 percent of the variation in PEPA combined score).

For neurotypical children, we investigated object substitution (NOS) (see figure 6). We included the working-memory scale of the BRIEF-P in the analysis because this was the strongest relationship. Neither language development nor cognitive development had a strong correlation to the NOS scores in this group, so we did not add this data to the regression analysis. The regression equation (NOS = 2.05 - 0.04 X working-memory score) indicated that the NOS standard score will decrease .04 for every point increase in the BRIEF-P working-memory score (that is, as object substitution ability decreases, so does working memory as reported by parents). The equation is a moderate predictor of the NOS score with an $R^2 = 0.23$ (that is, the equation predicts 23 percent of the variation in NOS scores).

Discussion

The executive monitoring of cognitive processes or executive function ability enables children to successfully engage in their everyday activities (Thibodeau-Nielsen et al. 2020). It is important to understand, for children with an ABI, the impact that reported deficits in executive function may have on the ability to participate in age-appropriate activities like pretend play. Engagement in pretend play (also called sociodramatic play) has been shown to have a positive effect on the development of executive function (Thibodeau et al. 2016: Esmaili et al. 2019: White et al: 2021). The purpose of this study was to investigate the relationship between pretend play and executive function in an effort to discover the elements of executive function that contribute to pretend play and that may help explain the deficits in pretend play seen in children with an ABI. Our hope is that a clearer understanding of this relationship will provide direction for pediatric ABI rehabilitation.

The results presented included both a global measure of executive function (GEC and EFT) and the component measures of working memory, inhibition, and shift. There is some evidence in preschool-aged children that the immature development of the components of executive function means a global measure may be a more appropriate measure (Francis and Gibson 2023: Garon, Bryson, and Smith 2008: Wiebe et al. 2011). While being mindful of this, we know there is an acceleration in development of executive function over the preschool period with working memory the first discreet domain to emerge followed by inhibition and then shift (Wiebe et al. 2011). With this in mind, we discuss the results of the individual domains.

The results of this study suggest it is plausible that the difficulties in executive function found in children with an ABI do manifest themselves in these children having difficulty engaging in pretend play. The GEC of the parent reported BRIEF-P score of the children with an ABI accounted for 37 percent of the variance in the PEPA score. GEC was also significantly corelated to the number of object-substitution scores of the neurotypical group. Similar results were reported by Francis and Gibson (2023), who found that a global executive function score significantly accounted for variance in pretend play in neurotypical children. In concert with others (Faja et al. 2016; Thibodeau et al. 2016), our study found working memory to be the most substantive contributor to a model predicting PEPA scores for children with an ABI—and for the neurotypical group it was the number of object substitutions (NOS).

Working memory is the ability to hold information in one's mind and refer to that information to complete a task (Diamond 2013). Working memory accounted for 54 percent of the variance in the PEPA combined score of the children with an ABI, and, in a combined model with general cognitive functioning, this percentage jumped to 66 percent. We find it interesting that general cognition and working memory were not significantly correlated for the children with an ABI, which meant their working-memory ability was not explained by general cognition. The best predictor of elaborate sequenced actions of pretend play for children with an ABI was their general cognitive function plus working memory, with working memory being the most significant contributor. It would seem reasonable that working memory is needed to be able to hold and update the story of the play in mind as purposeful actions that extend or contribute to the play narrative—including imaginary representations of attributions of properties and reference to absent objects—are added. The children with an ABI in our study had significantly higher scores on the parent-reported BRIEF-P, indicating they had more difficulty with working memory. They also had difficulty producing sequences of elaborate pretend play. Their play resembled a series of short interactions using one or two toys with a discrete narrative, and then came a pause in the play, a move to another toy, and an unrelated narrative, or the same short narrative was repeated. Pretend play of this type displays the difficulty these children have holding information in mind and using it then to add to or extend the play. There was only a weak correlation between working memory and the PEPA scores of children in the neurotypical group. Perhaps it is the increased difficulty with working memory experienced by the children with an ABI that exposed the vulnerability of the production of elaborate sequenced actions of pretend play, captured by the PEPA score, to deficits in working memory.

In the neurotypical group of children, working memory showed a strong correlation with object substitution ability and accounted for 23 percent of the variance in the number of objects substituted during the play. Our current study assessed a child's spontaneous use of object substitution within play production, with a variety of play materials—self-generated by the child—over an extended play period of eighteen to thirty minutes. It would seem that, for the neurotypical group of children, it was the variance in this ability that was significantly influenced by working memory. The number of object substitutions made in the play had a moderate but not significant correlation with working memory for children with an ABI. The number of object substitutions made in play by children with an ABI was low (mean = 7), and there was potentially not enough variance in the scores for a relationship to be identified.

According to Vygotsky (2016), inhibition is a critical skill that enables a child to engage in pretense and impose an alternate meaning on an object by the suppression of reality. Vygoysky also proposed that the engagement in pretend play enabled the development of self-regulation. This study found only a moderate and not significant correlation between the inhibition scores and PEPA combined scores of the group of children with an ABI. The neurotypical group had a moderate to strong but nonsignificant correlation between the inhibit scale as reported by parents and object substitution. Prompting children to continue playing if they left the play space or appeared to have finished playing before the required time was up did not significantly relate to inhibit for either group. It would make sense that children who required prompting to play would also be rated as having more difficulty with questions of impulsivity and completing tasks. What we find surprising is that the children with an ABI did not show a strong relationship between the variables.

Shift or cognitive flexibility is the ability to have learned and used one set of rules but then accommodate a new set and change behavior accordingly (Diamond 2013). The ability to shift is a strong predictor of creativity in older children (Krumm et al. 2018) and appears to be positively affected by participation in intense fantasy play (Pierucci et al. 2013). Object substitution in play in which one object is used as another would appear to draw on this ability. There was, however, no significant correlation between the number of object substitutions and the shift score of either group by parent report or direct measure in our study. Wiebe and her colleagues (Wiebe et al. 2011) contended the shift ability is the last to differentiate from a global executive function ability, and it may not have developed sufficiently in the current sample for a discreet relationship with object substitution to become apparent.

There was a strong relationship between difficulties in shift as reported by parents and the lower PEPA combined and PEPA symbolic (play with unstructured objects) score for children with an ABI. Playing elaborately with unstructured objects is a complex play skill, and children with ABI had significantly lower scores than the neurotypical group. It may be the case for children with ABI that the result represented an undifferentiated executive function ability. Because shift is the last to emerge as a distinct ability, perhaps the strong correlation result is more a representation of the relationship between the GEC and the PEPA score of this group. Certainly, shift did not significantly contribute to the model predicting PEPA scores for children with ABI.

Parent reports of planning and organizing ability in our study correlated strongly with the PEPA combined score of the children with an ABI, but again the plan-or-organize scale did not significantly contribute to a multiple regression model. The pretend play of preschoolers is characterized by the “making and solving” of problems in the play (Stagnitti 2021). Indeed, children engaged in self-initiated pretend play show increased independence in problem solving (Gmitrova and Gmitrov 2003) and counterfactual reasoning (Francis and Gibson 2023). In the play of the neurotypical group in this study, narrative was used to develop problems, which was the “oh-oh” moment in the play. The car had crashed or the animal figures had knocked down the fence and run away. The problems in the play then became an opportunity to create and play out solutions. The children with an ABI struggled to weave problems into their play and did not play out solutions. Planning and organizing is not widely reported as a core executive function ability in preschool-aged children. The BRIEF-P used by Skogan and associates (Skogan et al. 2016), however, does report planning and organizing as a core scale of preschool executive function. The questionnaire asks whether tasks are performed by the child in a logically sequenced way or if the child is able to follow instructions to complete tasks. These capacities do require planning and organized thought, as does sequencing play actions.

It is probable that the developmental relationship between pretend play and executive function is a complex interplay of the development of both abilities throughout childhood (Hopkins et al. 2016; Walker and Gopnik 2013). In our study, working memory with general cognitive ability was the most reliable predictor of pretend play ability for preschool-aged children with an ABI. The significantly poorer pretend play ability of the children with an ABI in our study could be a result of their poorer executive function. Pretend play has been shown to have a positive effect on the development of executive function (Esmaili et al. 2019), and it is protective of executive function development in children at risk, including children who have experienced life-threatening events, like children with an ABI (Thibodeau-Nielsen et al. 2020).

The pediatric rehabilitation environment needs to be expanded to encompass the developmental needs of children with an ABI (Anderson, Spencer-Smith, and Wood 2011; Ryan et al. 2016). These needs include executive function (Horton, Soper, and Reynolds 2010; Galvin and Mandalis 2009) and pretend play (Thorne, Stagnitti, and Parson 2021). Assessment of pretend play and executive function for children with an ABI is essential to ensure appropriately targeted rehabilitation intervention. The results in this study have shown there is efficacy in a clinical setting to using the ChIPPA assessment to gain understanding of a child's everyday activity of pretend play and to infer the emergent skills of executive function in preschool-aged children with an ABI. Assessment of preschool-aged children can be challenging. They present with a diversity of attention and language ability, particularly children with an ABI. Finding assessment tasks that children of this age have a competence in and can readily engage with is essential for good results (Wiebe et al. 2011). The play-based, child-initiated ChIPPA provides an opportunity to do this.

Future Directions and Limitations

This study examined the correlation between executive function and pretend play. Although the results offer an insight into a relationship between these abilities, it does not allow us to infer a causal relationship or attribute directionality to developmental influence. Investigations are warranted to determine if a targeted pretend play intervention does improve pretend play ability in children with an ABI and the impact of such intervention on subsequent executive function ability. This will also help clarify the relationship.

The sample size in our study was relativity small; and although the results are compelling, it is prudent to consider the results with some attention. One of our authors, Adrienne Thorne, completed all the assessments for the study. In doing so, she was fully aware of which group the children were in and the potential for bias. Standardized assessments, as well as independent assessments by parents, were used to minimize this bias. Inclusion of children with a range of ABI etiologies in the study limits comment on the difference in skill development that may exist in the pediatric ABI population. There may be significantly different presentations from the different injury etiology. A nonaccidental brain injury, for example, results in a more diffuse injury compared to the more confined injury profile of an accidental traumatic brain injury (Catroppa et al. 2017). The range in time since injury for children with an ABI could likewise be seen as a limitation, because it also adds variation to the sample. The children in our study were drawn from a limited geographical area, and this study did not attempt to record the different parenting, socioeconomic status, or family structures. Dysregulated and stressful family environments can impact a child's executive function (Chavez-Arana et al. 2018). These factors may have been at play for the children in the study and were beyond its scope.

Conclusion

This is the first study to explore the relationship between executive function and pretend play in children with an ABI. The knowledge gained from our study informs the provision of developmentally appropriate rehabilitation of preschool-aged children with an ABI, targeting the development of both pretend play and executive function. Inclusion of pretend play intervention in the rehabilitation of children with an ABI may well be the most effective way to induce development in executive function and pretend play of preschool-aged children with an ABI.

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