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Exploring Natural Pedagogy in Play with Preschoolers: Cues Parents Use and Relations Among Them

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Recent developmental work demonstrates a range of effects of pedagogical cues on childhood learning. The present work investigates natural pedagogy in informal parent-child play. Preschool-aged children participated in free play and a toy task with a parent in addition to a toy task with an experimenter. Sessions were extensively coded for use of pedagogical cues, such as eye contact and pointing. We present a series of analyses investigating the pedagogical cues that characterized natural pedagogy, how these cues related, and how cues bundled into facets. Implications for future research and determining the validity of these measures of natural pedagogy are discussed.

Introduction

From an early age, children actively seek out and acquire information from social partners, including their parents (e.g., Baldwin & Moses, 1996; Bruner, 1983; Harris, 2006; Tomasello; 1999; Tomasello, Kruger & Ratner, 1993, Vygotsky, 1978). Parents in turn engage in pedagogical interactions with their children in ways that transfer knowledge (Csibra & Gergely, 2006; 2009; 2011). Gergely and Csibra (2005; 2006) and others (e.g., Parker-Rees, 2007; Sage & Baldwin, 2010; 2011) believe that

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pedagogy plays a crucial role in children's success at knowledge acquisition, in part by helping learners identify what information is relevant. Adults may capitalize upon a set of pedagogical cues (like eye contact, pointing, and gaze shifting) to elicit from children a specific attentional and interpretative mindset – the pedagogical learning stance – that shapes their processing in ways that expedite learning.

This pedagogical learning stance has been noted across the ages. In seminal work, Shafto and Goodman (2008) reported that when adult learners adopt a pedagogical learning stance, they shift their hypotheses to better capitalize on the information provided by teachers. Adults' ability to engage in the pedagogical interaction in this manner resulted in quicker problem solving relative to when they believed the information being provided was generated randomly. Relatedly, Sobel and Sommerville (2009) reported that a pedagogical context helped 4-year-old children learn a sequence of lights with higher success when compared to children being provided with either an inappropriate rationale or no rationale at all for ordering the lights. Bonawitz et al. (2009) further described how pedagogy helped preschoolers focus on a specific function of a toy over-and-above accidental exposure. Kuhl (2007; 2010) has argued that social information is privileged in infancy as well. In her work on phonetic discrimination (Kuhl, Tsao, & Liu, 2003), infants responded with increased arousal and attention to a live speaker in comparison to a matched video or audio presentation. It could be argued that this speaker was inherently pedagogical in nature, providing cues like eye contact and pointing to help infants learn a non-native phonetic distinction that they would be expected to lose in the absence of exposure.

Given the cues provided by the teacher, it is likely that infants were placed into the "pedagogical learning stance," which helped them pick up on relevant information. Sage and Baldwin (2010) concur with this idea, suggesting that pedagogy is a specialized form of social learning. They explain that pedagogy may require a level of sophistication beyond that of other types of social learning

(e.g., observational learning) where learners simply respond with enhanced arousal or attention. In pedagogical interactions, the learner likely picks up on the instructional intent of the teacher and alters their processing in appropriate ways in order to enhance their learning.

Pedagogy is often examined in structured settings such as those just mentioned, but pedagogy also occurs more informally – for instance, in play. This is the focus of the present paper. Samuelsson and Carlsson (2008) refer to the "playing learning child," discussing how learning and play are often inseparable phenomena. We agree with this notion. The present work thus constitutes a first attempt to examine the pedagogical cues utilized by parents in play – a natural pedagogy environment – to provide a starting point for future work into this important phenomenon.

Characterizing Natural Pedagogy

Gergely, Csibra, and colleagues (Csibra; 2010; Gergely & Csibra, 2005; 2006; Gergely, Egyed, & Kiraly; 2007) discuss a handful of cues that they suggest are critical to pedagogical learning in infancy. Eye contact is important in maintaining a communicative link, and referring to a child by name is helpful in orienting children. Additional referential cues, such as gaze shifting and pointing, communicate where children should direct their attention in the immediate surround. Infant-directed speech is thought to be valuable in engaging children as well. As children age, particular types of language, such as explanations or questions, might take the place of infant-directed speech.

These suggestions regarding the phenomenon of natural pedagogy seem imminently plausible, but as-yet no systematic effort has been made to discover the extent to which they indeed characterize what parents actually do when engaging in pedagogical interactions with young children. That said, it is of course true that the literatures on cognitive and language development are rife with potentially relevant findings. For

example, Ninio (1980; Ninio & Bruner, 1978) reported that parents use "what" questions when reading picture books to children, and this was positively related to children's vocabulary acquisition. Similarly, Valle and Callanan (2006) found that parents often use relational analogies to teach children about science. Furthermore, Brand, Baldwin, and Ashburn (2002) found that mothers spontaneously engage in specialized action ("motionese") when demonstrating novel objects to infants, including increased repetitiveness and range of motion. However, because such research was not conceived with questions about natural pedagogy in mind, it is difficult to identify which sets of behaviours are specifically indicative of pedagogy, and whether they operate to elicit alterations in children's learning in the way that pedagogy is thought to do.

Despite the need for unveiling behaviours that characterize natural pedagogy, researchers often explicitly manipulate pedagogical context and then examine the effects on children's learning. In this work, researchers have opted to provide a range of cues signaling pedagogy, and the fact that systematic effects on children's learning were obtained suggests that at least some subset of these cues might play a role in successful pedagogical interactions. To illustrate, Sage and Baldwin (2011) presented infants with either a pedagogical (cues like eye contact/pointing directed to infant), social (identical motion stream, but adult acted as if performing actions for herself; no cues directed towards infant), or non-social (only hands visible; no cues or facial information) demonstration of using a hooked tool to retrieve an out-of-reach toy. The pedagogical and social demonstrations were both inherently social in that a person was present and demonstrating the skill for infants; however, infants were only exposed to specific cues indicative of pedagogy in the prior case. Infants witnessing the pedagogical demonstration later outperformed their peers at this tool-use task. Similarly, Rhodes, Gelman, and Brickman (2010) found that 5-year-old children successfully attended to sample composition and made inferences about biological properties only if the samples were presented pedagogically. Other research points

to the unique effects of pedagogy on childhood learning across a variety of domains (e.g., Csibra, 2010; Sobel & Sommerville, 2009; Topal, Gergely, Miklosi, Erdohegyi, & Csibra, 2008).

Given the robust effects of pedagogy in experimental settings, pedagogy seems likely to also arise spontaneously in more informal settings, such as parent-child play. Relevant to this, Bonawitz and colleagues (2011) documented that preschoolers are sensitive to pedagogy in a play context. In their work, pedagogy focused children's attention to particular functions of a toy while also restricting exploration during play. However, this play occurred in a typical experimental context, and re-examining such play in a more informal context would be beneficial for the study of natural pedagogy.

Play has an inherently pedagogical function. Bekoff and Byers (1981) reported that play acts as a form of "training" for kids, in terms of learning motor and cognitive skills, as well as being socialized with others. Giesbrecht (2012) also supports that play may be helpful in children's development in terms of increasing their social competence, creative thinking, and problem solving skills. She asserts that children engaged in more adult-directed or structured play may have different academic and social capacities in comparison to other children. Steen and Owens (2001) also support that the environment during play activities can be constructed to create optimal learning situations, and that we may engage in learning during play without even explicitly meaning to. Thus, play seems a worthwhile backdrop for examining more informal pedagogy between parents and children, as it provides rich opportunities for teaching and learning.

The preceding work provides interesting insights into how a pedagogical context affects learning. These findings derive from carefully controlled studies employing pedagogical cues in one context and comparing it to a context lacking such cues. However, pedagogy may also occur in naturalistic settings like play. The natural parent-child relationship might be constituted such that

parents are ubiquitously providing information that children are disposed to absorb and consider relevant. The aim of our work is to shed light on this natural pedagogy phenomenon. In a play situation, both parent and child are engaging in a social process where both individuals' activities are relevant and interdependent. The parent likely contributes to child play by engaging in certain cues to pedagogical intent (e.g., points out the lever on a jack-in-the-box to get the child engaged). In the present work, we were curious about these pedagogical cues that parents capitalize on in interactions with children, and how such cues are interrelated. Our study is fundamentally exploratory in nature, and is simply designed to provide new insight into the "natural pedagogy" phenomenon.

The Current Study

In quick review, then, the present study investigated natural pedagogy between parents and children. Of key interest were what cues parents capitalized upon, how these cues were interrelated, and how we might distinguish a high from a low pedagogical parent. To explore these questions, preschool-aged children participated in a free play session with their parent, followed by a series of toy tasks that involved both learning and teaching about novel toys.

Method

Participants

Thirty-two children participated: sixteen 3-year-olds (M = 41.8 months, *range* = 36.2 – 47.8 months, half male) and sixteen 4-year-olds (M = 53.09 months, *range* = 49.1 – 59.5 months, half male), along with their primary caregivers (29 mothers, 3 fathers). All children were developing typically and lived in a college town or its surround. Participants were primarily white and middle-class. Parent-child dyads were randomly assigned to receive instructions during the consent process that they were going to be

engaging in teaching (n = 16) or playing (n = 16) activities. Data from one additional child were omitted from final analyses due to insufficient English proficiency.

Materials

We constructed two toys that were novel to children and each equipped with four functions. See Figure 1 for a description of both toys.

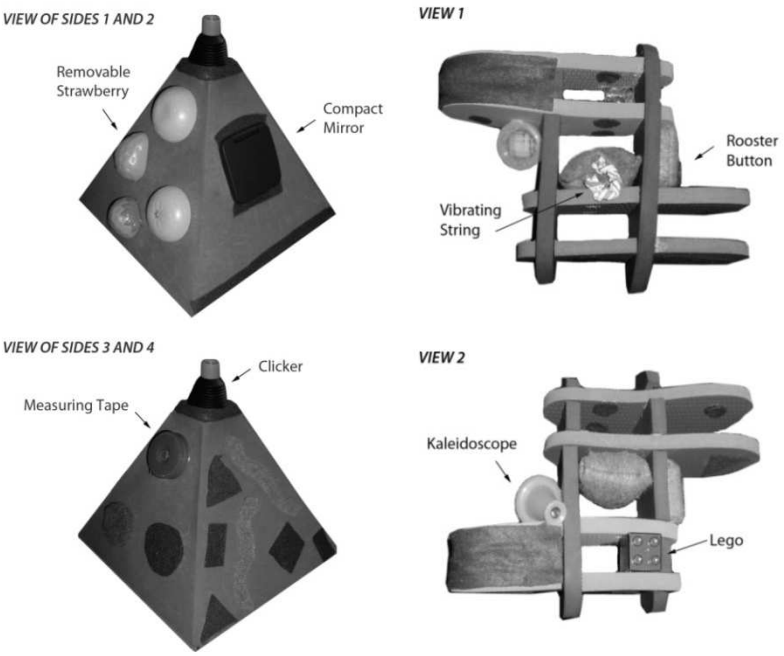

Figure 1. *Pyramid and Flops Toys*

Procedure

Parents first completed the consent process, where half of parents were informed that they would be engaging in play activities and half of parents were told they would be engaging in teaching activities.

Children then participated in a five-minute free play session with their parent. There were 15 toys on the floor. Toys were of a diverse nature, including a train and slide, puzzle, jack-in-the-box, bouncy ball, noise-making ball, Furreal puppy, Mater car (from Cars), bus, keyboard, and ball spinner. Parents had the option of sitting on the floor or in a chair.

Children next participated in four toy tasks. The tasks included: (1) children being taught the functions of either the Pyramid or Flops toy by a parent, (2) children teaching the functions of that toy to the experimenter, (3) children being taught the functions of the other toy by the experimenter, and (4) children teaching the functions of that second novel toy to their parent. Which toy was first and which adult taught which toy were counterbalanced across children. Only one adult was in the room at a time, while the other adult waited in the hallway. A doorbell sound was used to signal the end of each task. Prior to parents entering the room with the toy they would be teaching, the experimenter gave them instructions that they were supposed to teach their child about the toy. When the experimenter taught the child, a pedagogical script was followed to provide comparable teaching sessions across children. At the end of tasks 1 and 3, children were told that the other adult was going to come in, and that (a) she had never seen or heard anything about the toy, and (b) it was the child's job to teach her how to use the toy. Children needed to signal comprehension by nodding or saying something applicable, or they were given additional clarification.

The experimenter demonstrated all four functions to children. Parents were not pre-exposed to the toy, and thus they did not necessarily teach everything. We opted not to show the parents all functions in advance in order to elicit their natural response when exposed to a new toy that they needed to teach to their children. When later coded, 21 children saw all 4 functions during the parental teaching task, 9 children were exposed to 3 functions, 1 child to 2 functions, and 1 child to 1 function. There was also the possibility for child discovery during the teaching of the parent-taught toy since the parent did not have a strict script – indeed, 12 children discovered at least one function on their own.

Coding and Reliability

Free play. Taking into consideration the literature on pedagogical cues used with young children (Csibra, 2010; Csibra & Gergely, 2009; 2011; Gergely & Csibra, 2005; 2006, Gergely, Egyed, & Kiraly, 2007), one coder reviewed all play sessions for frequency of pedagogical cues. The specific cues coded were: name referral, eye contact, gaze shifts, referential speech, pointing, demonstrations, and joint attention. An initial viewing of the videos and a consideration of the age group suggested that linguistic cues also provided important indicators of pedagogy, thus utterances of the parent were also recorded and divided into four categories: suggestions, knowledge questions, explanations, and observational statements. See Table 1 for a definition of each cue. We also recorded the proportion of time parents chose to sit on the floor in the play area versus at a distance in the chair, and the number of toys played with by the child.

Parents were also assigned a subjective pedagogical score – a 1-5 scale indexing how pedagogical they appeared to be during the play session (1 = not pedagogical at all and 5 = very pedagogical with the child). As we will discuss later, we believe this subjective score is meaningful, as it is correlated with more objective pedagogical behaviours and was scored reliably between coders.

Table 1. *Definitions of Cue Types*

Cue Type	Definition
Name Referral	Parent said the child's name (e.g., "Hey Peter!")
Eye Contact	Parent made direct eye contact with the child (back-and-forth eye contact between child and toy counted under 'gaze shifts' below)
Demonstrations	Parent demonstrated a new function for a toy (e.g., how to use the jack-in-the-box, or how to look for clues on the puzzle pieces)
Pointing	Parent pointed to something in the room (e.g., points directly to the bus or to the lever on the jack-in-the box)
Referential Speech	Parent said either "Look!" or "Watch!" or a variant thereof (e.g., "Look here", "Watch this")
Gaze Shifts	Parent shifted gaze from child to toy to child (child not necessarily making eye contact)
Joint Attention	Parent and child are jointly attending to a toy or specific play activity* (e.g., both parent and child are putting the puzzle together)
Suggestions	Parent provided a suggestion for what the child should do next or what something might be ("Did you try the yellow bus?", "Do you want to put the puzzle together?")
Knowledge Questions	Parent tested the child's knowledge (e.g., "What does it do?", "Do you remember that song?")
Explanations	Parent explained why something happened or how something worked for their child (e.g., "Oh, I think the car is too big for the ramp", "Look at how it has springs, that means it will bounce!")
Observations	Parent described the current state of playing or the toys (e.g., "It doesn't look like Mater has a hat today" "Oh, you like that one")

*Joint attention was only measured during free play (i.e. not in the toy tasks since all time was spent in joint attention given the close proximity of the set-up). Also, joint attention was the only cue to be measured in proportion of time (out of 5 minutes). The remaining cues were measured based on frequency.

Parent-teaching toy task. The parent-teaching toy task was coded for the same pedagogical cues as the free play, with the exception of joint attention (since the parent was always in close-proximity). We also coded how many and which functions the parent taught.

Child-teaching toy tasks. The child-teaching toy tasks were coded for the number of functions children taught the adult, as well as the number of pedagogical cues that children displayed.

Reliability. A second coder blind to the initial coder's frequency counts and ratings reviewed half (n = 16) of the videos for frequency of pedagogical cues and assignment of pedagogy ratings. Coders agreed within a margin of +/- 1 on 88% of the reported frequencies assigned to each pedagogical cue (84% for linguistic cues, 90% for non-linguistic cues). Given our allowed discrepancy of +/-1 on the frequency assigned to each cue, we further examined whether the second coder's disagreements were evenly split above and below the first coder's reported frequency. A t-test revealed no systematic differences across this split ($t(50)$ = -0.12 , p = 0.91), suggesting that disagreements were randomly distributed. Additionally, the two coders' frequency ratings were highly correlated (r = 0.82, $p < 0.001$), further confirming the reliability of the frequency counts. On the subjective pedagogy ratings, coders agreed within a margin of +/- 1 on 98% of the ratings, and their ratings were significantly correlated (r = 0.73, p = 0.001).

Criterion for Significance

Given the exploratory nature of the present study and the relatively small sample size, employing across-the-board Bonferroni corrections seemed too conservative to be warranted. However, we thought it sensible to set a higher criterion for rejecting the null hypothesis. Thus, for all analyses, we set 0.01 as the requisite level for meeting statistical significance.

Results

Preliminary Analyses

Differences based on instruction type. As mentioned earlier, half of parents were told they were going to engage in play activities while half of parents were told they were going to engage in teaching activities. Of initial interest was to determine whether informing parents that they would be engaging in teaching versus playing would affect their use of pedagogy; in other words, perhaps telling parents they were going to teach would enhance their use of pedagogical cues. A MANOVA taking into account all pedagogy measures at once, as multiple indices of a common underlying construct, revealed no difference between these instruction groups ($F(1,30) = 10.775$, $p = 0.24$). Thus, results presented hereafter were collapsed across groups.

We were also curious if parents' use of pedagogical cues would differ between the free play and parent-taught toy task. Parents' number of cues per minute was not significantly different between free play ($M = 4.24$, $SD = 1.85$) and the parent-taught toy task ($M = 3.72$, $SD = 1.28$, $t(31) = -1.52$, $p = 0.14$). Taken together, these analyses suggest that pedagogical cue use was omnipresent across contexts.

Age differences. Many developmental advances occur during the preschool years. Thus, we were initially interested in whether pedagogical interactions differed as a function of age. Only two significant findings emerged. A *t*-test revealed that parents taught their 3-year-olds more functions of the novel toy ($M = 3.88$, $SD = 0.34$) than their 4-year-olds ($M = 3.25$, $SD = 0.86$, $t(30) = 2.71$, $p = 0.01$) during the toy task. Age and the number of pedagogical cues the child used while teaching the Flops to an adult were also positively correlated ($r = 0.44$, $p = 0.01$). These limited significant findings point to natural pedagogy being rather uniform across ages, thus results presented hereafter were collapsed across age groups.

Natural Pedagogy

We conducted a series of exploratory analyses aimed at characterizing natural pedagogy during the free play session. Specifically, we sought to determine which cues occurred frequently enough to indicate that they were important features of the pedagogical process. We also tried to discern how these cues interrelated.

Cues "toolkit". To begin, we wanted to get a sense of which pedagogical cues parents typically use. For the 10 pedagogical cues measured in frequency (name referral, eye contact, suggestions, explanations, knowledge questions, observational statements, pointing, referential speech, gaze shifts, and demonstrations), we recoded the frequencies with either a 1 (parent used cue once or more) or 0 (parent never used cue). We then looked at the number of parents who had used the cue at least once. The pedagogical cues utilized by most parents in the play session were pointing, referential speech, gaze shifting, suggestions, knowledge questions, and observational statements. A smaller number of parents utilized demonstrations and explanatory statements, while even fewer parents used name referral and eye contact (and it was relatively rare even when they did so). These findings give us a sense of the "toolkit" of cues that parents typically use during free play (see Table 2).

Table 2. *Toolkit of Cues – Number of Parents by Cue Type*

Cue	Used cue at least once	Did not use cue
Name Referral	10	22
Eye Contact	9	23
Demonstrations	16	16
Explanations	19	13
Pointing	28	4
Referential Speech	23	9
Gaze Shifts	20	12
Suggestions	31	1
Knowledge Questions	31	1
Observations	27	5

Do cues interrelate? Another way to explore the pedagogical cues used during free play was to examine the correlations among cues. Of interest was whether these cues tended to relate to each other in predictable ways; in other words, perhaps parents high in one type of cue were particularly high in another type. Given that we refrained from providing any suggestions for the free play session (e.g., we did not instruct parents to use certain cues given our interest in natural pedagogy), it was unclear how cues might relate. Correlations between cues might suggest that parents tend to capitalize upon these cues together. Conversely, the absence of correlations might suggest that parents rely typically on just certain cues.

The outcome of these correlational tests yielded a couple of interesting observations (see Table 3). First, the pedagogical cues were strongly interrelated with the exception of name referral. This suggests that parents do seem to capitalize upon multiple pedagogical cues during free play. Second, our subjective pedagogy rating (the 1-5 scale) seemed to capture the pedagogy phenomenon effectively, given that it showed strong relations to the pedagogical cues used frequently by parents. It is perhaps unsurprising that the pedagogy rating correlated with many of the most commonly recruited pedagogical cues, as raters were likely unconsciously paying attention to the same cues.

Also in agreement with our initial exploration, the pedagogy rating was not significantly related to name referral or eye contact (rare cues) or to the less common cue of explanatory statements. This absence of a relationship might arise simply because these cues were rare and thus there was not a large enough sample within which to see relationships emerge. Alternatively, these cues may well not be indicative of natural pedagogy in this age range. Similarly, one possible explanation for the absence of a relationship between the subjective pedagogy rating and observational comments is that parents make observational comments primarily for non-pedagogical purposes, and the other cues are more reflective of natural pedagogy.

Table 3. *Correlations between Pedagogical Cues in Free Play*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Floor Time	--													
2. # Toys	-.37*	--												
3. Pedagogy Rating	.54**	-.54**	--											
4. Name Referral				--										
5. Eye Contact					--									
6. Pointing			.55**			--								
7. Referential Speech			.52**		.40*		--							
8. Gaze Shifts	.47**		.48**					--						
9. Demonstrations			.42*		.49**		.57**		--					
10. Suggestions		-.35*	.52**			.51**				--				
11. Explanations									.42*		--			
12. Knowledge Qs			.40*									--		
13. Observations						.38*							--	
14. Joint Attention - Close	.66**	-.46**	.70**					.47**				.37*		--

* $p < .05$ (marginal), ** $p < .01$

Interestingly, the subjective pedagogy rating was also negatively correlated to the number of toys children played with during the free play session, suggesting that children played with fewer toys if their parent was rated as highly pedagogical. It is no surprise then that joint attention was (a) also negatively correlated to number of toys played with by the child, and (b) positively correlated to the parent's subjective pedagogy rating. Parents who were jointly attending to the toys in close proximity to the child were more pedagogical and were aiding in focusing their children's attention to fewer toys during free play.

Noting that cues were interrelated, we opted to conduct an inter-item reliability analysis; the resultant Cronbach's alpha of 0.54 pointed to the cues being moderately intercorrelated. This suggests that the 11 pedagogical cues may cohere as a unitary phenomenon. To examine these issues in greater depth, we next undertook a principal components analysis.

Principal components analysis (PCA). To examine the dimensionality of our pedagogy measures, we conducted a principle components analysis including our 11 main pedagogical cues. This analysis was exploratory, given our relatively small sample size of 32. However, we were curious if cues could be bundled into separate components, as this might provide guidance regarding predictions about the phenomenon of natural pedagogy in future work. Our initial PCA extracted 5 components with Eigenvalues greater than 1. However, a review of the corresponding scree plot suggested that components 4-5 were not meaningful (Cattel & Vogelman, 1977); all components coming after the initial "elbow" in the scree plot were eliminated. Table 4 shows the 3 components and the corresponding loadings of the cues.

Table 4. *Loadings of Cues in PCA*

Variable	Component		
	1	2	3
Demonstrations	.769		.330
Referential Speech	.756		
Eye Contact	.733		
Explanations	.622		
Time in Close JA		.367	.830
Suggestions		.750	
Pointing		.708	
Knowledge Qs		.676	
Gaze Shifts			.831
Observations			
Name Referral			

Note. Rotated Component Matrix; Extraction Method: Principal Components Analysis; Varimax Rotation. Only factor loadings greater than .30 are shown.

After rotation, the first component (Eigenvalue = 2.16) accounted for 19.67% of the variance in our measures. Four pedagogical cues positively loaded: demonstrations, referential speech, eye contact, and explanations. This component could possibly be labeled as a "demonstrative" component as it seems to represent how demonstrations unfold. For instance, one could imagine that an adult said "watch!", made eye contact, performed the demonstration, and explained it.

The second component (Eigenvalue = 1.79) accounted for an additional 16.27% of the variance, and perhaps represents an "information provision" component, with suggestions, pointing, joint attention, and knowledge questions positively loading onto it. It should be noted here that joint attention barely met the threshold for inclusion – with a loading just over 0.30. It seemed to contribute more substantially to the third component.

The third component (Eigenvalue = 1.60) accounted for an additional 14.58% of the variance, and could possibly be labeled

as a "joint attention" component – joint attention and gaze shifts had very high positive loadings, while demonstrations barely surpassed our 0.3 criterion. This suggests that gaze shifting by the parent between the child and toys often occurs during joint attention episodes, and this may sometimes be accompanied by demonstrations.

Name referral and observational statements failed to load onto any component. This is in line with our findings that observational statements are rather unrelated to other aspects of pedagogy, and name referral is rarely used.

Comparing high to low pedagogical parents. A final way that we looked at these data was to divide parents into two bins - high and low pedagogical groups - to see if there was a difference between how these groups engaged in cue use. In order to divide parents into bins, we computed a composite score for pedagogy with all of the cues measured in frequency summed except observational statements (since observational statements did not relate strongly with the other cues, but was frequent). The median was 19.5 cues. A median split resulted in a low pedagogy group (n = 16) engaging in an average of 12.25 cues (SD = 4.92) and a high pedagogy group (n = 16) engaging in an average of 26.13 cues (SD = 6.23), a significant difference according to a t-test ($t(30)$ = -6.97, $p < 0.001$). The two groups also differed significantly in subjective pedagogy ratings ($t(30)$ = -7.09, $p < 0.001$), with the low group averaging a rating of 1.69 (SD = 0.6) and the high group averaging a rating of 3.75 (SD = 1). These particular analyses provided important information, as it is logically possible that parents were simply huddled at the centre of the scale and were not significantly variable.

Next, we used the information acquired from the PCA analysis to identify differences between low and high pedagogical parents based on their relative use of the three components of pedagogical behaviour (see Table 5). Since joint attention was measured as a proportion while the rest of the cues were measured in frequency,

it was omitted from its place in the components, but a separate *t*-test confirmed that high pedagogical parents spent a higher proportion of time in joint attention with their children than low pedagogical parents. We conducted three t-tests with high versus low pedagogy group entered as the grouping variable and the averaged use of the pedagogical cues specified by the component as the variable of interest. For all three components of pedagogy, high pedagogical parents engaged in more of these behaviour patterns than low pedagogical parents.

Table 5. *Cue Use by High versus Low Pedagogical Parents*

	High Pedagogical *M* (*SD*)	Low Pedagogical *M* (*SD*)	*t*	*p*
Component 1 Demonstrative Branch	5.68 (4.51)	2.37 (1.96)	-2.69	.01*
Component 2 Information Provision	18.19 (7.19)	8.75 (4.25)	-4.52	.000**
Component 3 Joint Attention Branch	3.25 (2.4)	1.18 1.47)	-2.92	.007*
Time in joint attention	.75 (.34)	.39 (.39)	-2.78	.009*

* $p \leq .01$, ** $p \leq .001$

Relations between Parent and Child Pedagogy

We were curious if, when given the opportunity to take on the role of teacher, the child's pedagogy mirrored that of their parent. Thus, we ran a series of correlations to see if children's pedagogical cues were related to that of their parent (e.g., did parents who use many points have children who used many points?). Analyses relating parents' use of pedagogical cues during free play to children's use of pedagogical cues in the toy tasks revealed two positive relations. Parents' use of referential speech was positively correlated to children's use of referential speech in

the child-taught toy task with the parent (r = 0.52, p = 0.002) and with the experimenter (r = 0.45, p = 0.009). No other correlations were significant (ps > 0.01).

We also examined if parents with a high frequency of cue use had children with a similarly high frequency. Children's overall frequency of pedagogical cues while teaching an adult was unrelated to their parent's use of pedagogical cues from the free play session when the child taught both the Flops (r = 0.10, p = 0.58) and the Pyramid (r = -0.05, p = 0.80). Similarly, children's frequency of pedagogical cues while teaching was unrelated to their parent's use of cues from the parent-teaching task for both the Flops (r = -0.03, p = 0.88) and the Pyramid (r = 0.04, p = 0.81). Overall, these analyses seem to show that child pedagogy is largely unique relative to that of their parents, at least in this context of teaching an adult about a toy.

Discussion

In this exploratory study, we investigated natural pedagogy in parent-child play. We were specifically interested in the cues that typically occurred in pedagogical interactions, whether these cues were related to one another in systematic ways, and whether these cues were useful in distinguishing between parents high versus low in pedagogy. We coded free play sessions between three- and four-year-old children and their parents for pedagogical cues identified via past literature (e.g., Csibra & Gergely, 2009; 2011). Initial analyses revealed that points, gaze shifts, referential speech, suggestions, observational statements, and knowledge questions were used by many parents, while only some parents utilized demonstrations and explanations. Perhaps surprisingly, parents rarely used eye contact or name referral. This seems surprising given the emphasis on these as important pedagogical cues in prior literature. Perhaps parents did not capitalize on these latter two cues given the age of children, as three- and four-year-olds are already quite fluent in making and receiving conversational bids (Miller & Sperry, 1988).

Interestingly, parents provided equal levels of pedagogical cues regardless of whether the context was framed in advance as involving teaching versus playing. Furthermore, we noted that parents did not differ in cue use between the free play and teaching tasks. This absence of a difference seems open to a variety of interpretations, even ones quite conflicting in nature. For example, the lack of difference in rates of pedagogical cues between contexts could lead one to question whether pedagogy is a separable construct from such related constructs as parental engagement or warmth, given that the cues seem to be omnipresent even when interactions are not explicitly pedagogical. If in fact these cues are ubiquitous across interaction contexts, one wonders how they act to specifically signal pedagogical intent. On the other hand, however, a body of existing findings clearly indicates that infants read these cues as indicative of pedagogical intent, and alter their processing accordingly (e.g., Gergely, Egyed, & Kiraly, 2007; Sage & Baldwin, 2011; Topal et al., 2008). Alternatively, then, equivalent rates of pedagogical cues across teaching and play contexts might arise because pedagogy indeed is nearly ubiquitous in the way parents are inclined to interact with children, perhaps especially when invited into a laboratory setting. Our subsequent analyses were largely predicated on the assumption that this is a viable interpretation.

An examination of correlations between pedagogical cues displayed many relations among various cues, and at the same time suggested that name referral was unrelated to the other cues, and observational statements might not be closely linked to pedagogy either. A principal components analysis then suggested that pedagogy involves several separable dimensions, which we ultimately conceptualized as focusing on demonstration, information provision, and joint attention. This showcases the idea that pedagogy might be best viewed as a multidimensional construct, with differing cues subserving distinguishable sub-goals. Furthermore, the finding that high pedagogical parents spent a higher proportion of time in joint attention with their children than the low pedagogical parents ties in nicely with recent

findings dictating that joint attention mediates the relationship between socio-emotional engagement and conversational skill development (Farrant, Fletcher, & Maybery, 2012).

We were also interested in whether behaviour patterns revealed by the PCA had the power to distinguish between highly pedagogical parents versus parents less inclined toward pedagogy. High pedagogical parents indeed engaged in more of the pedagogical behaviour patterns. It is also critical to note that our study had only 32 dyads - a relatively small sample for analyses of this kind. This makes replication an important aim.

We also found evidence that pedagogy has important effects on children's learning and exploration. Sixty-eight percent of children learned all four functions when taught by a parent in the current study versus 19% of children when left solely to their own exploration (noted in a separate group of 16 children). Clearly, as might be expected, pedagogy helps to broaden children's knowledge. At the same time, evidence that pedagogy constrains children's exploration also arose, akin to findings by Bonawitz and colleagues (2011) who reported that children played less with a novel toy as a result of witnessing a pedagogical demonstration of a single function. In their work, it is possible that the teacher's failure to show the other functions was construed as evidence for their absence, leading the children to focus on the single demonstrated function. Though measured in a fundamentally different manner, our findings also point to pedagogy acting in ways to constrain exploration. We found that effective teachers may actively keep children focused through such cues as demonstrations and linguistic utterances, which results in children acting upon fewer toys. Another possibility, however, is that children are fully guiding their own choices, and, as a result, highly pedagogical parents take their children's lead and engage in cues, which may simply stall more expansive exploration.

It should be briefly mentioned that Western families are tuned to use pedagogical cues as a means of knowledge transfer. Parents in

other cultures may or may not use pedagogy in this same way. For instance, Barbara Rogoff and colleagues point to some cultures, such as Mayans, relying more heavily on observation as a means of learning in contrast to direct teaching (Rogoff, Mosier, Mistry, & Goncu, 1993). Thus, it is important to keep in mind that the results discussed here are specific to the Western phenomenon of pedagogy.

Issues of Validity and Future Directions

One important set of issues to consider concerns validation of the phenomenon of natural pedagogy as a viable construct. That is, prior work (e.g., Csibra & Gergely, 2009; 2011; Gergely & Csibra, 2005; 2006; Sage & Baldwin, 2011; Topal et al., 2008) postulates the pedagogy phenomenon and attendant cues to pedagogy, but as-yet little work validates the pedagogy construct explicitly. Consider discriminant validity; is pedagogy a unique construct, distinguishable from related phenomena like parental engagement or sensitivity?

Construct validity remains another issue to be resolved. Gergely, Csibra, and colleagues (Csibra, 2010; Gergely & Csibra, 2005; 2006; Topal et al., 2008) have taken the lead in conceptualizing natural pedagogy, and, in the present research, we measured pedagogy by means of a range of behaviours that they have suggested are important cues, such as name referral, gaze shifts, pointing, and the like. Whether these cues indeed reflect pedagogical intent, as they are thought to, is a question of some importance, however. One way to approach this issue is to examine whether parents are more likely to provide such cues when explicitly asked to engage in pedagogy. It is likely that these cues occur to some extent whenever a parent is engaging a child, but may occur to a greater extent when they are specifically prompted to teach. Recall that we included a context-setting manipulation of this kind; half of parents were asked to engage in play activities with their child, and half were asked to engage in teaching activities. Interestingly, however, these differing

instructions resulted in no systematic differences in parents' use of pedagogical cues. While this finding is of real interest, it also seems to raise possible concern on the construct validity front. That said, it could of course be the case that our context-setting manipulation was not strong enough to elicit differences in parents' interaction style with children. It is also quite plausible that pedagogical intent pervades parents' interactions with children, even play activities, at least for Western middle-class parents. In sum, in our view, empirical evidence for construct validity of the phenomenon of natural pedagogy remains scant, and this issue deserves attention.

Furthermore, it is worth noting some differences between our findings and that of the infancy literature. Csibra and Gergely (2009; 2011) suggested that name referral was an important cue for infants in terms of capturing their attention and signaling teaching intent. It would be interesting to compare a wider age range in free play and toy tasks similar to those discussed here in order to determine whether and how proper name usage is linked to developmental status. For instance, there might be a shift between infancy and the preschool years where children, as they come to recognize and form more words, begin to expect that language will help them encode information relevant to the self versus someone else in an interaction (Chiat, 1986). Thus, name referral might not be used simply for orientation as described in the infancy work, but perhaps also to help older children interpret information as relevant for the self. In the current study, we found that relatively few parents used name referral with preschool-aged children, instead favoring other physical and linguistic cues like pointing and asking knowledge questions. Future work should focus on how name usage evolves with age, and when parents transition to utilizing a child's name less and perhaps start to focus more on other pronouns (see Smiley, Chang, and Allhoff, 2011 for a related piece of work).

It is also worth reiterating that only a small number of parents utilized eye contact during free play. Eye contact seemed critical

in the infant work, likely given that it provides a communicative link not yet possible with language. Given that significant developments occur as children age, it is possible that some of the pedagogical cues analyzed here are simply not necessary for older children to engage in pedagogical reasoning.

Past work with preschoolers has focused on how teaching alters learning in a manner that goes beyond what would be learned from identical information presented in a non-pedagogical way (e.g., Bonawitz et al., 2011). With that research aim in mind, the cues may seem largely irrelevant except to the extent that they signal the teacher's intent. Such a hypothesis (that most cues are irrelevant, or that perhaps one cue would suffice) should be tested in future work. In addition, future work must demystify the criteria for what constitutes a functional pedagogical cue in order for us to better understand the nuances regarding use of cues in naturalistic interaction. For example, should all cases of pointing be regarded as instances of cuing pedagogical intent, or are some pointing gestures more pedagogical than others?

In sum, the present research provides some initial information to better characterize the phenomenon of natural pedagogy in parents' interactions with their preschoolers. At the same time, this work makes clear that current understanding of natural pedagogy is limited and future work must delve into the many remaining questions addressed here.

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References

Baldwin, D. & Moses, L. (1996). The ontogeny of social information gathering. *Child Development,* 67(5), 1915-1939.

Bekoff, M. and Byers, J. (1981). A critical reanalysis of the ontogeny and phylogeny of mammalian social and locomotor play: An ethological hornet's nest. In K. Immelmann, G. W. Barlow, L. Petrinovich, & M. Main (Eds.), *Behavioural Development: The Bielefeld Interdisciplinary Project* (pp. 269-337). Cambridge: Cambridge University Press.

Bonawitz, E., Shafto, P., Gweon, H., Goodman, N., Spelke, E., & Schulz, L. (2011). The double-edged sword of pedagogy: Instruction limits spontaneous exploration and discovery. *Cognition, 120*(3), 322-330.

Brand, R., Baldwin, D., & Ashburn, L. (2002). Evidence for 'motionese': Modifications in mothers' infant-directed action. *Developmental Science, 5*(1), 72-83.

Bruner, J. (1983). *Child's talk: Learning to use language.* New York: Norton.

Cattell, R. & Vogelmann, S. (1977). A comprehensive trial of the scree and KG criteria for determining the number of factors. *Multivariate Behavioural Research, 12,* 289-325.

Chiat, S. (1986). Personal pronouns. In P. Fletcher & M. Garman (Eds.), *Language acquisition* (pp. 339-355). Cambridge, England: Cambridge University Press.

Csibra, G. (2010). Recognizing communicative intentions in infancy. *Mind and Language, 25*(2), 141-168.

Csibra, G. & Gergely, G. (2006). Social learning and social cognition: The case for pedagogy. In: *Y.* Munakata & M.H. Johnson (Eds.), *Processes of change in the brain and cognitive development. Attention and performance. XXI.* (pp. 249-274). Oxford: Oxford University Press.

Csibra, G. & Gergely, G. (2009). Natural pedagogy. *Trends in Cognitive Sciences, 13*,148-153.

Csibra, G. & Gergely, G. (2011). Natural pedagogy as evolutionary adaptation. *Philosophical Transactions of the Royal Society B, 366,* 1149-1157.

Farrant, B., Maybery, M., Fletcher, J. (2012). Socio-emotional engagement, joint attention, imitation, and conversational skill: Analysis in typical development and specific language impairment. *First Language, 31*(1), 23-46.

Gergely, G. & Csibra, G. (2005). The social construction of the cultural mind: Imitative learning as a mechanism of human pedagogy. *Interaction Studies, 6,* 463-481.

Gergely, G. & Csibra, G. (2006). Sylvia's recipe: Human culture, imitation, and pedagogy. In S. Levenson & N. Enfield (Eds.), *Roots of Human Sociality: Culture, Cognition, and Human Interaction.* (pp. 229-255). Oxford: Berg Publishers.

Gergely, G., Egyed, K., & Kiraly, I. (2007). On pedagogy. *Developmental Science, 10*(1), 139-146.

Giesbrecht, S. (2012). The Pedagogy of Play. *Education Canada, 52*(1), 1-2.

Harris, P. (2006). Social cognition. In W. Damon (Editor-in-Chief), R. M. Lerner, D. Kuhn & R. S. Siegler (Eds.), *Handbook of child psychology: Vol. 2. Cognition, perception, and language* (6th ed., pp. 811-858). New York: Wiley.

Kuhl, P. (2007). Is speech learning 'gated' by the social brain? *Developmental Science, 10,* 110-120.

Kuhl, P. (2010). Brain mechanisms in early language acquisition. *Neuron, 67*(5), 713-727.

Kuhl, P., Tsao, F., & Liu, H. (2003). Foreign-language experience in infancy: effects of short-term exposure and social interaction on phonetic learning. *Proceedings of the National Academy of Sciences, USA,* 100, 9096-9101.

Miller, P. & Sperry, L. (1988). Early talk about the past: The origins of conversational stories of personal experience. *Journal of Child Language, 15,* 293-315.

Ninio, A. (1980). Picture-book reading in mother-infant dyads belonging to two subgroups in Israel. *Child Development, 51*(2), 587-590.

Ninio, A. & Bruner, J. (1978). The achievement and antecedents of labeling. *Journal of Child Language, 5,* 1-15.

Parker-Rees, R. (2007). Liking to be liked: imitation, familiarity, and pedagogy in the first years of life. *Early Years, 27*(1), 3-17.

Rhodes, M., Gelman, S. & Brickman, D. (2010). Children's attention to sample composition in learning, teaching, and discovery. *Developmental Science, 13*(3), 421-429.

Rogoff, B., Mosier, C., Mistry, J., & Goncu, A. (1993) Toddlers' guided participation with their caregivers in cultural activity. In E. Forman, N. Minick, & A. Stone (Eds.), *Contexts for learning: Sociocultural dynamics in children's development.* New York: Oxford University Press.

Sage, K. & Baldwin, D. (2010). Social gating and pedagogy: Mechanisms for learning and implications for robotics. *Neural Networks, 23,* 1091-1098.

Sage, K. & Baldwin, D. (2011). Disentangling the social and the pedagogical in infants' learning of tool use. *Social Development, 20*(4), 825-844.

Samuellson, I. & Carlsson, M. (2008). The playing learning child: Towards a pedagogy of early childhood. *Scandinavian Journal of Educational Research, 52*(6), 623-641.

Shafto, P. & Goodman, N. (2008). Teaching games: Statistical sampling assumptions for pedagogical situations. *Proceedings of the 30th annual conference of the Cognitive Science Society.*

Sobel, D. & Sommerville, J. (2009). Rationales in children's causal learning from others' actions. *Cognitive Development, 24*(1), 70-79.

Smiley, P., Chang, L., & Allhoff, A. (2011). Can Toddy give me an orange? Parent input and young children's production of I and you. *Language Learning and Development, 7*(22), 77-106.

Steen, F. & Owens, S. (2001). Evolution's pedagogy: An adaptationist model of pretense and entertainment. *Journal of Cognition and Culture, 1*(4), 289-321.

Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge: Harvard University Press.

Tomasello, M., Kruger, A. C., & Ratner, H. H. (1993). Cultural learning. *Behavioural and Brain Sciences, 16*, 495-552.

Topal, J., Gergely, G., Miklosi, A., Erdohegyi, A., & Csibra, G. (2008). Infants' perseverative search errors are induced by pragmatic misinterpretation. *Science, 321*, 1831-1834.

Valle, A. & Callanan, M. (2006). Similarity comparisons and relational analogies in parent-child conversations about science topics. *Merrill-Palmer Quarterly, 52*(1), 96-124.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* US: Harvard University Press.