

Appendix 1 – Research Report

RESEARCH PROJECT SUMMARY

This study investigates abstract conceptual learning and generalisation abilities, focusing on abstract financial concepts. This research is carried out within an ecological context of naturalistic social interactions, where the moment-to-moment dynamics are examined, including measures of both teacher and learner, verbal and non-verbal behaviours, individual and dyadic, behavioural and neural measures. The first objective of this project is to study whether the brain-to-brain synchronisation can predict successful learning of financial abstract concepts, compared to cases in which children did not successfully learn the concepts. The second objective is to ground this neural coupling to the behaviours taking place at specific timepoints during the interaction by evaluating whether and which verbal (e.g., questions and answers, number of turns) and non-verbal (e.g., gestures, facial expressions) behaviours correlate with learning. The final objective is to test the correlation between neural coupling with the verbal and non-verbal behavioural coordination to establish whether and how each specific behaviour contributes to brain synchronisation. Finally, we study whether the role of the different coordinative behaviours and brain coupling on learning changes across development, above and beyond standard measures of children’s linguistic and cognitive skills. Overall, this study allows us to achieve a comprehensive understanding of the underlying behavioural and neural mechanisms that support children’s learning of financial abstract concepts within a naturalistic social interaction.

METHODS AND FINDINGS

Participants

This research study involves children aged between 6 and 11 years old. This broad age group is divided into three groups: 6-7, 8-9, 10-11. At present, we have collected data from 52 dyads comprising: 10 6-7 year-old; 29 8-9 year-old and 13 10-11 year-old children.

All participants are recruited through London schools, social media, and UCL parents' community. Participants had to be native English speakers, and children had to be typically developing. Additionally, participants had to have non-fixed hairstyles compatible with the fNIRS cap. Demographic information about the caregivers and children recruited is provided in the table below (Table 1). The study obtained full ethical approval from the UCL Research Ethics Committee (ID number: 24039/001).

Table 1. Demographic characteristics of dyads by child age group.

Age Group	N (dyads)	Child Age M (SD)	Child Sex	Caregiver Age M (SD)	Caregiver Sex
6–7 years	10	6.99 (1.05)	4 boys, 6 girls	41.78 (8.26)	3 m, 7 f
8–9 years	29	8.78 (0.77)	8 boys, 21 girls	44.28 (3.72)	7 m, 22 f
10–11 years	13	11.24 (0.80)	6 boys, 7 girls	43.54 (5.09)	3 m, 10 f

Study design

The caregiver-child dyads engage in an interactive game-style task in which the caregiver teaches the meaning of novel abstract concepts to the child. The child is shown an array of four pictures in each trial and is asked to select the corresponding picture to the target concept. The child's overall learning outcomes are evaluated within the main experimental session, as well as one week after, to evaluate whether the learning is sustained over time.

Stimuli Development Overview

The development of the experimental stimuli required a dedicated, multi-stage process to ensure that the materials were both scientifically rigorous and pedagogically appropriate for children's financial learning.

1. **Selection of Financial Concepts:** Financially relevant abstract concepts were identified through educational resources, including children's books and national financial literacy frameworks. Concepts were chosen based on age-of-acquisition norms, ensuring they were unfamiliar but learnable for the relevant age groups.
2. **Elicitation of Conceptual Associations:** Online studies were conducted with English-speaking adults to gather real-world descriptions of situations associated with each concept.
3. **Development of Pictorial Stimuli:** For each financial concept, three representative situations were selected: two for use in learning trials and one for use in testing trials. Non-financial abstract concepts were also included as foils to control for task difficulty and visual properties. Refined descriptions were converted into design briefs, reviewed by the research team, and then illustrated by a professional graphic designer (Ms Marcy Goberman).

This process produced a rigorously designed set of child-appropriate financial literacy stimuli—unique visual materials that not only served the current study but can also be used as a resource for broader educational initiatives in children's financial literacy.

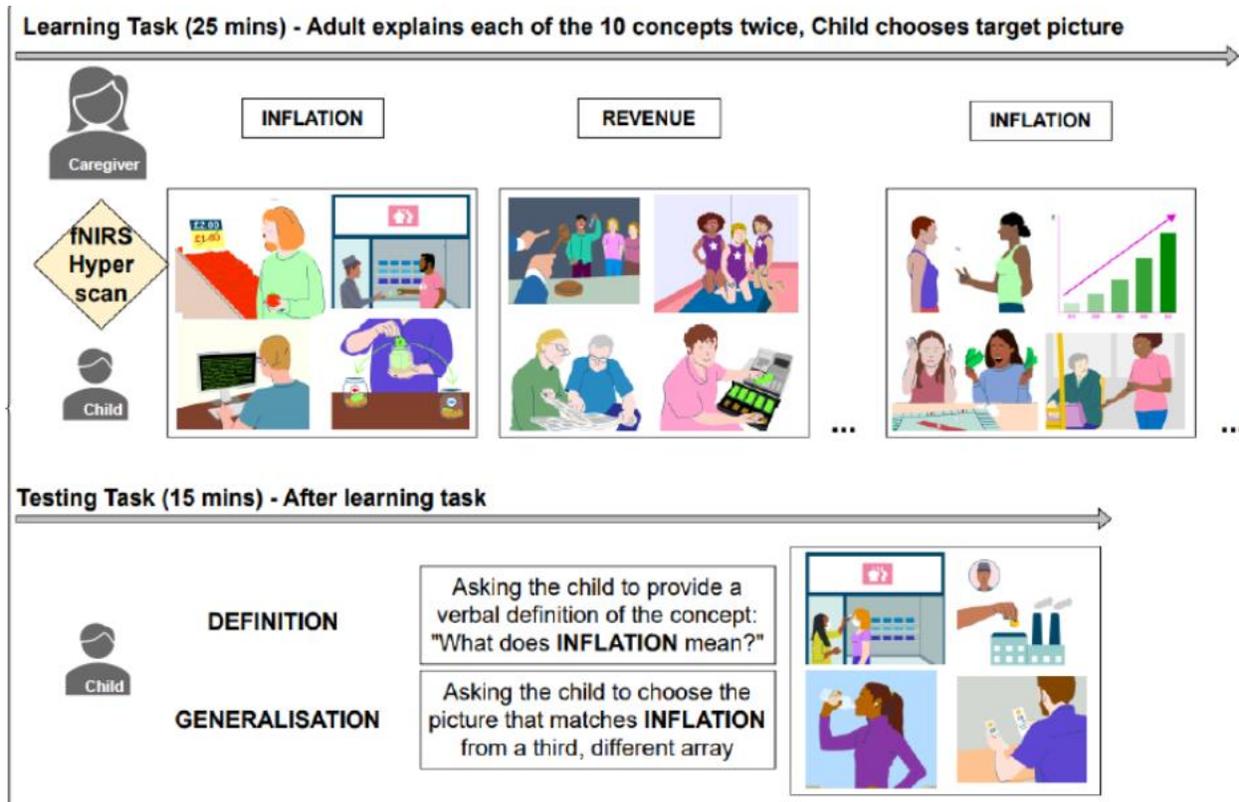
Experimental procedure

The study involves a short, pre-experiment online questionnaire where we collect demographic information about the participants and present additional information about the study to the caregivers as well as 3 experimental sessions: one main in-person session, an online follow-up session one week later, and a final face-to-face session where we implement language and cognitive evaluations.

The first, main experimental session is conducted in person and consists of a concept learning task and a testing task, in which the caregiver teaches novel concepts to their child while we record the brain activity of both caregiver and child simultaneously using functional near-infrared spectroscopy. In this learning phase, the adult and child are asked to interact naturally, and to have a conversation about the different concepts. The child is tasked with selecting a picture before the end of the trial using their touchscreen laptop. Across the learning phase, each concept is presented twice, each time with different target pictures and fillers. This has the goal of encouraging the child to learn about each concept across different contexts of real-world scenarios thus to generalise the meaning across varied situations. During testing, the child is asked to verbally explain what the meaning of the concepts they were exposed to is. Secondly, for each concept, the child is shown a

third, yet different array of pictures to the ones seen during learning and is asked to select the corresponding picture for each concept. The main experimental session design including the learning and testing phase can be seen in **Figure 1**.

Figure 1. Main experimental session design: learning and testing phase



The second session is scheduled for a week after the first in-person session. The follow-up consists of an online video call between the child and the experimenter, who repeats the testing task conducted in the main in-person session. Additionally, we collect cognitive measures from both caregiver and child during a third face-to-face meeting at UCL or at participants' homes, scheduled within four weeks from the first main experimental session. These include receptive vocabulary of the child (measured with the British Picture Vocabulary Scale – Third Edition (Dunn et al., 2009); working memory of the child (measured with the Di the Digit Span subtest of the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV; Grizzle, 2011) and theory of mind of both child and caregiver assessed using an adaptation of the Frith-Happé Animations Task (Livingston et al., 2021).

Learning Outcomes – Definition Scores

Children's learning of novel financial abstract concepts was evaluated by asking them to provide verbal definitions of the concepts. The speech of children defining the newly learnt concepts is manually transcribed and scored in a scale from 0 (i.e., the child gave no answer or provided an incorrect response to the target concept) to 2, based on its conceptual accuracy and completeness. An ad-hoc definition scoring criteria (**Table 2**) was developed for this purpose, informed by the

established vocabulary subtest of the WISC-IV. Note: in all analyses reported below, we collapse scores of 1 and 2.

Table 2. Definition Scoring Criteria for Children’s Verbal Definitions of Newly Learnt Concepts

Concept	Score = 1 (Partially Correct)	Score = 2 (Fully Correct)
Auction	Includes one of the following: bidding process, highest bidder wins, or item has value.	Includes two or more of the following: bidding process, highest bidder wins, item has value.
Bankruptcy	Mentions having no money or being unable to pay.	Explains inability to pay debts, provides a cause or example.
Debt	Mentions owing money.	Explains it is due to borrowing or discusses being out of debt.
Employment	Mentions having a job.	Mentions getting paid or explains the hiring process.
Fraud	Mentions scam, hacking, or a specific example without general definition.	Provides a general definition and a relevant example.
Inflation	Mentions rising prices or gives an example.	Describes effects of inflation, such as reduced affordability.
Insurance	Mentions fixing/replacing things when bad things happen.	Mentions paying for insurance or how it works.
Revenue	Mentions getting money or income.	Relates revenue to business, production, or income streams.
Subsidy	Mentions financial help or money received.	Explains government source or non-repayable nature.
Taxation	Includes one of the following: paying part of income, paying to the government, or use of tax money.	Includes two or more of the following: paying part of income, paying to the government, use of tax money.

Multimodal Data Recording and Annotation

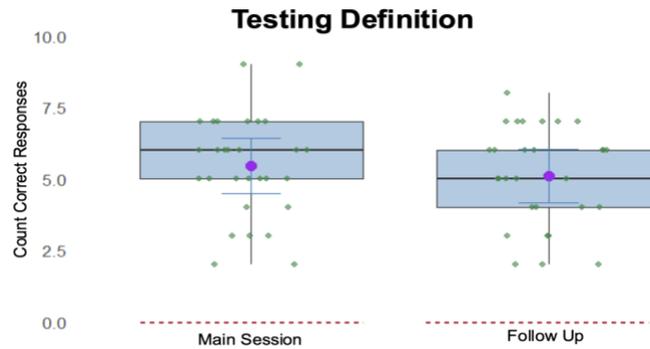
In this study, we video record the whole caregiver-child interaction, allowing us to capture both verbal and non-verbal behaviours. The annotation of these behaviours involves a combination of automated and manual pipelines and includes both quantitative as well as qualitative measures as described below.

RESULTS (note: all results presented here refer to children aged 8-9 (29 dyads))

Overall Learning

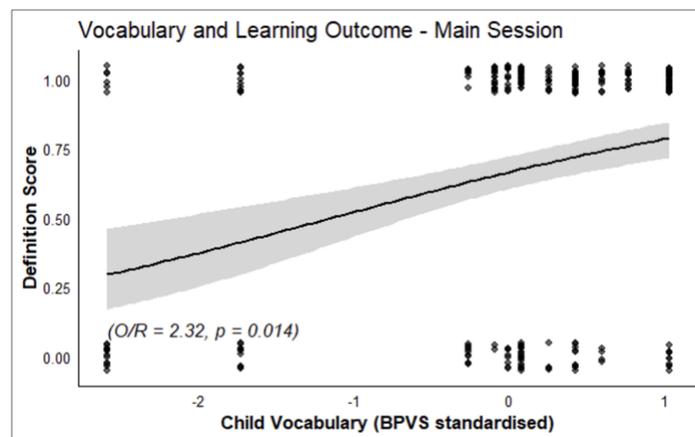
Results from the definition learning outcome show that children are able to learn the meaning of novel concepts and that they can retain their knowledge also at follow up, one week after the main session, obtaining a mean score of 7.45 ($SD = 3.51$) in the main session and 7.5 ($SD = 3.64$) at follow up (Figure 2).

Figure 2. Number of Correct Responses in the Definition Task in the Main Session and at Follow-up.



Additionally, children’s vocabulary is a significant predictor of learning ($p < 0.05$) (**Figure 3**)

Figure 3. Effect of Child Vocabulary Score on Learning Outcome (Definition Score in Main Session).



Considering that this is a newly developed task, having children with higher vocabulary scores obtain higher definition scores is a useful “sanity check” showing that the task is working as expected.

Behavioural Results

Qualitative Analyses of Caregivers’ Verbal Behaviours (teaching strategies)

In addition to the coordinative verbal behaviours reported last year, we have conducted a qualitative analysis of caregiver’s teaching strategies to identify those that predict children’s learning of novel financial concepts. The transcribed caregivers’ speech was annotated qualitatively to identify the spontaneous instructional strategies that were used during the interaction. Together with MSc student Ms. Dora Szegedi, we developed the Mentalizing and Pedagogical Strategies (MAPS) codebook, which captures a range of verbal strategies used by the caregivers to explain abstract concept (**Table 3**). MAPS is based on pedagogical literature.

Table 3. The Mentalizing and Pedagogical Strategies (MAPS) Coding Scheme

Strategy	Subcategory	Definition	Example
Explanations	2 nd person	Definition using “you”	“You are in debt when you spend more money than you have.”
	1 st person plural	Definition using “we”/“us”	“When we have inflation, it means things we buy cost more.”
	Other (1 st person singular / 3 rd person)	Detached explanation using “I,” “(s)he,” or “someone”	“A subsidy is something the government gives to encourage behaviour.”
Personal Examples		Real-life example from the child’s or family’s immediate context	“Like what happened to Grandma when her credit card got stolen.”
Hypothetical Examples	2 nd person	Imagined scenario involving the child	“Imagine if you couldn’t afford food because prices kept rising.”
	1 st person plural	Hypothetical scenario including “us”	“Insurance protects us if we’re in a car accident”
	Other (1 st person singular / 3 rd person)	Imagined scenario using “I,” “someone,” or third party	“Let’s say a person bids £100 and someone else bids £120.”
	Analogies	Comparison between concepts that have similar features	“Like a balloon inflating, prices are getting bigger, that’s inflation.”
Maintaining Rapport / Homeostasis		Praise, validation, or emotional check-in	“This one’s tricky, you’re doing great.” / “How are you doing, chicken?”
Checking for Common Ground		Assessing prior knowledge or familiarity	“Do you know what taxation means?”
Checking for Understanding	Explicit	Direct comprehension check	“You get it?” / “So, what is inflation?”
	Implicit	Inferred check through probing	“Who wins an auction?” / “Do you think it’s a problem to be in debt?”
Talking About the Pictures		Referring to or discussing the visual stimuli	“Do any of the pictures look like a job?”
Bringing in Other Financial Concepts		Using another financial concept to explain the target	“Bankruptcy is when you can’t pay off your debts anymore.”

We used a generalised linear mixed effect model to examine the strategies as predictors of children’s learning during the main session. Results are summarised in **Table 4**.

Table 4. Predictors of Learning in Main Session

DV: Learning (0/1) in Main Session				
Category	Predictors	Odds Ratios	CI	P
	Intercept	1.97	0.44 – 8.71	.373
Cognitive	Child’s Vocabulary (BPVS-3)	1.03	1.00 – 1.06	.029*
	Child’s Working Memory (WISC-IV DS)	0.90	0.82 – 0.99	.030*
Demographic	Child’s sex (girl vs. boy)	0.43	0.19 – 0.93	.033*
Task Design	Testing Order Main Session (picture-first vs. definition-first)	2.29	1.12 – 4.68	.023*
Pedagogical Strategies	Explanations: “you/we/us” > “I/(s)he/they/someone”	0.88	0.44 – 1.77	.726
	Personal Examples	0.63	0.43 – 0.94	.022*
	Hypothetical Examples: “you/we/us” > “I/(s)he/they/someone”	2.37	1.15 – 4.89	.019*
	Maintaining Rapport / Homeostasis	0.80	0.59 – 1.08	.153
	Checking for Common Ground	2.00	1.24 – 3.25	.005**
	Explicit Understanding Check	0.97	0.75 – 1.27	.851
	Implicit Understanding Check	2.51	1.38 – 4.57	.003**
	Talking About the Pictures	0.94	0.74 – 1.20	.632
	Bringing in Other Financial Concepts	0.94	0.67 – 1.31	.705
Interaction(s)	WM x Financial Concepts	1.08	1.01 – 1.16	.024*
Random Effect(s)				
	σ^2	3.29		
	τ_{00} dyad	0.00		
	τ_{00} concept learnability	0.66		
	ICC	0.17		
	N dyad	29		
	N concept learnability	2 (more/less likely to be learned)		
	Observations	252		
	Marginal R^2 / Conditional R^2	.406 / .505		

Note. $p < .05^*$, $p < .01^{**}$, $p < .001^{***}$; WM = Child’s Working Memory

Several strategies used spontaneously by the caregivers predicted learning, such as checking for common ground (e.g., “Do you know what taxation means?”), checking for implicit understanding (e.g., “Who wins an auction?”) and giving hypothetical examples that were child centered (e.g., “Imagine you couldn’t afford food because prices kept rising”). In contrast, other strategies like giving personal examples related to the child’s life reduced the odds of learning. Additionally, we found a significant interaction between working memory and the use of non-target financial concepts while explaining a different one. When caregivers introduced other financial concepts within a trial, whether previously taught targets or general financial terms (e.g., explaining debt as “similar to a loan”), the likelihood of learning decreased for those with lower working memory but increased for children with higher working memory.

These results underscore the importance of perspective-sensitive, dialogic approaches for learning abstract concepts in social interaction and offer practical insights for promoting financial literacy.

Non-verbal Behaviours - Eye Gaze

In addition to talking to one another, caregivers and children can also look at each other (mutual gaze). Gaze is known to be an important social signal that both directs attention, informs of communicative intention, and coordinates the dynamics of conversation. Mutual gaze (i.e., sustained eye contact between individuals) creates a connection between the people engaged in the interaction, potentially enhancing the child’s attention to the task, maintaining engagement and thus facilitating information processing.

Instances of mutual gaze were manually annotated to examine whether longer mutual gaze durations in the learning session predicted successful learning of novel concepts.

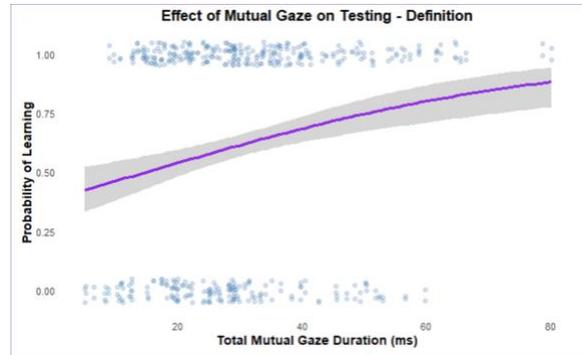
In a generalised linear mixed effect regression model including verbal dynamics, mutual gaze and individual cognitive scores as predictors of learning outcome (definition scores), we found that in addition to the child’s vocabulary (OR=4.02, $p<0.001$), total mutual gaze duration also significantly predicted children’s learning (OR=2.35, $p<0.001$), whereas including cognitive predictors and mutual gaze, none of the verbal coordinations were significant predictors, see **Table 5**.

Table 5. GLMM with Verbal Coordinative Behaviours and Mutual Gaze as Predictors of Learning (definition score) at the Main Session.

<i>Predictors</i>	Definition – Main Session		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
(Intercept)	2.40	0.88 – 6.51	0.086
Prop Backchannel / Total Utterances	1.13	0.86 – 1.48	0.384
Prop Open Questions / Total Questions	1.07	0.82 – 1.39	0.614
Total Mutual Gaze Duration	2.35	1.59 – 3.45	<0.001
Vocabulary Child (BPVS)	4.02	2.32 – 6.97	<0.001
Working Memory Child (Digit Span)	0.74	0.46 – 1.21	0.236
Random Effects			
σ^2	3.29		
τ_{00} participant	0.81		
τ_{00} trial	2.07		
ICC	0.47		
N participant	26		
N trial	10		
Observations	458		
Marginal R^2 / Conditional R^2	0.243 / 0.596		

As can be seen in **Figure 4**, children in dyads who engaged in longer durations of mutual gaze had higher probability of learning the novel concepts.

Figure 4. Effect of Total Mutual Gaze Duration on Predicted Probability of Learning Outcome (Definition – Main Session)

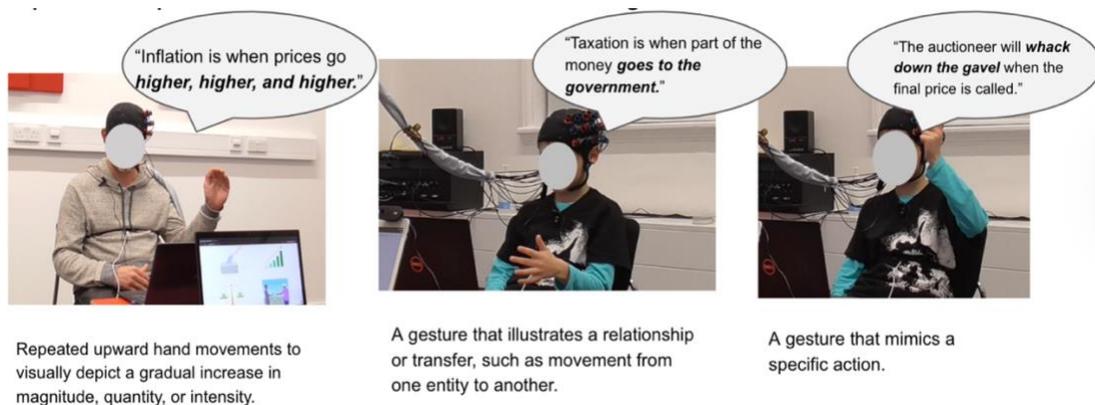


This findings are line with previous research on the role of mutual gaze supporting socio-emotional engagement and verbal information encoding during conversation, and reinforces the importance of investigating the non-verbal behaviours that occur in face-to-face interactions to establish a comprehensive understanding of how children learn novel concepts in typical real-world settings, namely in social interactions with others.

Non-verbal Behaviours - Gestures

Teaching from the caregiver can also include manual gestures that bear some meaningful link to the concepts explained. Likewise, children can also show their understanding by using meaningful gestures. Hand gestures, in particular, have been shown to play an important role in supporting learning of concrete concepts, but less is known about their role in learning abstract concepts within natural face-to-face interactions. The videos of the recorded interactions between caregivers and children were manually annotated to identify the occurrence of hand gestures. We focus on gestures that are *representational* (i.e., that have a meaningful relationship to the concept) and non-representational (i.e., that do not convey conceptual information but rather help maintain the flow of conversation). We expect that representational gestures help making the abstract concepts more concrete and therefore easier to learn. Examples of representational gestures in the study can be seen in Figure 5.

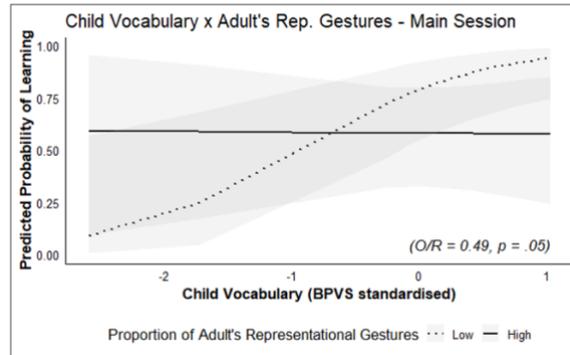
Figure 5. Examples of Representational Gestures Spontaneously Occurring during the Interactive Learning Task



In a preliminary generalised linear mixed effect regression analysis ($n = 18$ dyads) with verbal behaviours as well as representational gestures by both caregiver and child, we find that

representational gestures support learning. In particular, caregiver’s representational gestures improve immediate learning of children with lower vocabular (Figure 6).

Figure 6. Effect of Child Vocabulary and Adult’s Use of Representational Gestures on Predicted Probability of Learning (Definition – Main Session).



Thus, we see that representational gestures that highlight specific aspects of the meaning of the concept are helpful for children whose linguistic skills are weaker.

Brain-to-brain Synchronisation

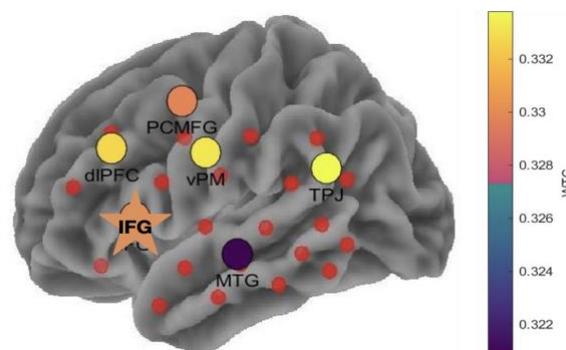
We have improved our analytical pipeline to include both automated and manual methods that increase the localisation accuracy of the measurement source. This allows us to assign each channel of each participant to a Region Of Interest (ROI), chosen on the basis of being regions involved in social cognition, language processing and communication and that have been found to synchronise across participants during cooperative tasks. With the new localised data by ROI rather than by channel, we built a generalised linear mixed effect regression model predicting the child’s learning outcome from the value of brain-to-brain coherence observed in the specified ROIs (Table 6).

Table 6. GLMM with WTC values in ROIs as Predictors of Learning (definition score) at the Main Session.

testing main definition transcript binary			
Predictors	Odds Ratios	CI	p
(Intercept)	3.99	0.61 – 25.93	0.147
IFG lo	1.38	1.00 – 1.91	0.047
MTG lo	0.92	0.67 – 1.26	0.611
TPJ lo	0.87	0.64 – 1.19	0.386
dIPFC lo	0.78	0.57 – 1.07	0.117
trial number	0.94	0.52 – 1.71	0.843
Random Effects			
σ^2	3.29		
τ_{00} dyad	5.39		
τ_{00} concept	3.84		
ICC	0.74		
N dyad	20		
N concept	10		
Observations	352		
Marginal R ² / Conditional R ²	0.016 / 0.741		

Results show that in the low frequency band (0.02-0.03Hz), brain-to-brain synchronisation as measured by wavelet transform coherence – on the left Inferior Frontal Gyrus (IFG) was a significant predictor of learning outcome in the main session (**Figure 7**).

Figure 7. Visualisation of the 22-channel array projected onto the MNI brain template with highlighted regions of interest (ROIs). Colors represent average wavelet transform coherence (WTC) values across dyads and trials, as indicated by the color bar. The inferior frontal gyrus (IFG, marked with a star) emerged as the ROI where stronger brain-to-brain synchronisation significantly predicted children’s learning outcomes.



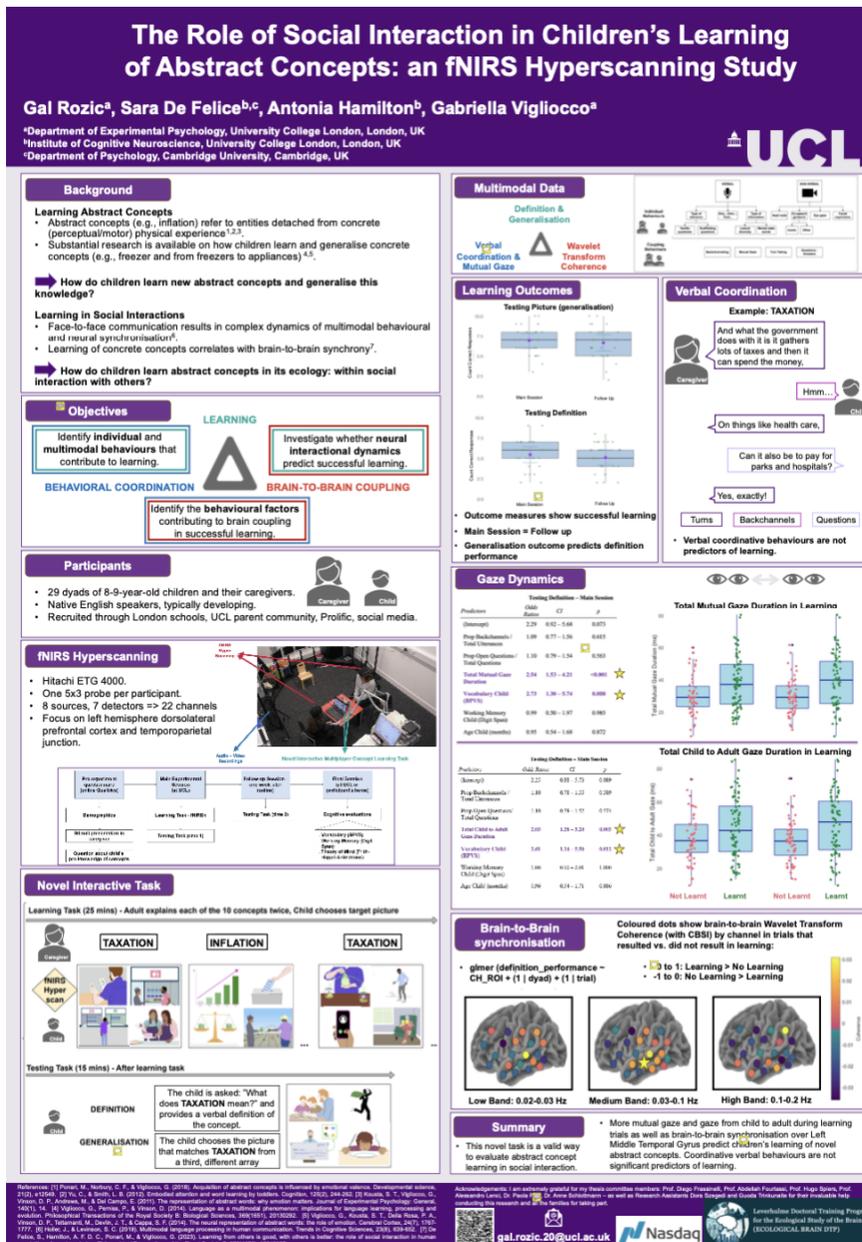
Thus, successful learning is indexed by brain-to-brain synchronization. Coherence was observed over the left IFG, an area engaged in language and social communication, possibly relating to a conceptual alignment on the topics being discussed and learnt.

OVERALL CONCLUSIONS AND REMAINING TASKS

Overall, the study has been progressing steadily yielding insightful findings regarding the different behaviours and neural dynamics that predict successful learning of financial abstract concepts. Not only are we validating that the newly developed interactive concept learning task works, as children are successfully learning the meaning of novel concepts, but we are also able to identify the specific behaviours and brain-to-brain synchronisation dynamics that support this process. The study has also generated great interest in the research community, with several abstracts being accepted – and invited - at international research conferences and awards received for these. A crucial aspect of this project is being able to determine the developmental trajectories of learning and to investigate whether the predictors identified as significant for this first age group, are also relevant for other age ranges. We must take advantage of the materials, tasks, and analysis pipelines developed so far to further elucidate the mechanisms that support the learning of financial concepts of younger and older children, as this would provide a comprehensive understanding of the development of learning abilities and the role of naturalistic social interaction in this process.

Appendix 2 – Research Posters

Poster. Social and Affective Neuroscience Society (SANS) 2025. Rozić, G., De Felice, S., Hamilton, A., & Vigliocco, G.. *The Role of Social Interaction in Children’s Learning of Abstract Concepts: an fNIRS Hyperscanning Study.* (25 April 2025 – Chicago, USA). Awarded the Experimental Psychology Society Grindley Travel Grant.



Poster. International Society for Gesture Studies (ISGS) 2025. Yi, S., Rozic, G., Vigliocco, G.. *The influence of gestures on children's learning of abstract concepts in social interaction.* (11 July 2025 - Nijmegen, The Netherlands).

The Role of Gestures in Children's Learning of Abstract Concepts in Interaction With Their Caregivers

Siqi Yi, Gal Rozic, Gabriella Vigliocco

Department of Experimental Psychology, University College London

Introduction

- Abstract concepts lack clear physical referents and are harder to learn and generalise than concrete ones. They rely more on emotional, social, and linguistic context than sensorimotor experience (e.g., Vigliocco et al., 2014).
- Caregivers' multimodal behaviours are shown to facilitate children's word learning of novel object labels and vocabulary growth (e.g., Jordan Monteiro Barros et al., 2025 - see Symposium IV at this conference)
- Gestures play an important role in supporting learning (e.g., Goidin-Meadow, 2003). **But less is known about their role in learning abstract concepts within natural face-to-face interactions.**

→ **Do gestures help children learn new abstract concepts above and beyond verbal information in naturalistic settings?**

Method

Participants

- 15 dyads of caregivers (M = 44.76 years, SD = 3.93) and their children (M = 8.18, SD = 0.53).
- Native English speakers, typically developing.

Materials

- 10 target financial concepts with age of acquisition (AoA) between 9.5 and 12.5 years (Brysbart et al., 2013).
- 3 distinct pictures for each of the 10 target concepts.

Measure of learning outcomes

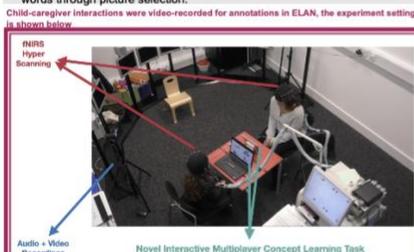
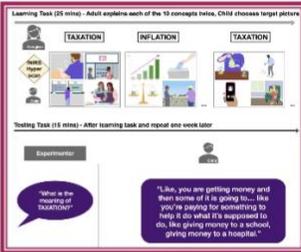
- **Definition-learning:** verbally explain the concepts to an experimenter.
- Binary outcomes: 0 = an obviously incorrect response; 1 = a correct response
- Immediately after the learning session and repeated a week later.

Verbal Behaviours

- **Lexical Diversity (TTR):** Ratio of unique words to total words(tokens).
- **Mean Length of Utterance (MLU):** Average number of words per utterance.

General Cognitive Measures

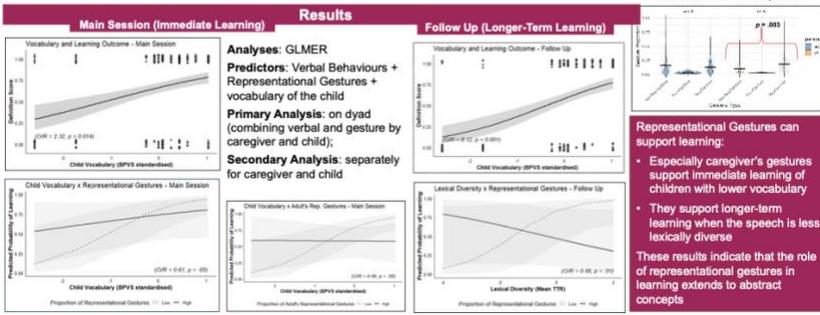
- **British Picture Vocabulary Score (BPVS):** measures children's understanding of spoken words through picture selection.



Gesture Annotation
(adapted from the ECOLANG manual (Gu et al., 2025)).

- **Representational Gesture** – depict an aspect of the referent
- **Non-representational Gesture** - included pragmatic, beat, or rhythmic movements that did not directly convey conceptual content;
- **Pronoun Gesture** - referred to the speaker or listener (e.g., pointing to oneself)

Examples of Representational Gestures in the Learning Task



Poster. The British Psychological Society Division of Educational and Child Psychology Conference (DECP) 2025. Szegedi., D, Rozic, G., Vigliocco, G. *Introducing MAPS: A novel codebook for mapping Mentalizing And Pedagogical Strategies in social interactions.* (9 January 2025 – Manchester, UK).

Introducing MAPS: A novel codebook for mapping Mentalizing And Pedagogical Strategies in social interactions

Dora Szegedi^{1,2}, Gal Rozic¹, Nura Alkathiri², Gabriella Vigliocco¹

¹Department of Experimental Psychology, University College London, London, UK
²Anna Freud, London, UK

Introduction

The Problem

- ❖ **Teaching and learning are social processes**, with children acquiring much of their knowledge through interactions with caregivers, teachers, and peers¹. However, research lacks a systematic tool to capture the diverse strategies used in real-world teaching contexts.
- ❖ Focusing solely on the teacher or learner, and studying learning in isolated settings, neglects the role of mentalizing—how teachers anticipate and respond to learners' cognitive and emotional states.

The Opportunity

- ❖ The **MAPS codebook categorises verbal strategies** caregivers use to explain novel concepts. It is:
 - ❖ Grounded in research on caregiver-child communication, pedagogy, and mentalizing^{2,3,4}.
 - ❖ Informed by Hattie's (2023)⁵ synthesis of 2,100+ meta-analyses on achievement.
 - ❖ Developed iteratively using a dataset of child-caregiver interactions from a broader fNIRS hyperscanning study focused on abstract concept learning.

Methodology

Participants: 28 child-caregiver dyads, who use English as primary language in the home.

- ❖ **Children:** 21 girls, 7 boys; $M_{Age} = 8.29$ ($SD_{Age} = 0.53$); neurotypical
- ❖ **Caregivers:** 21 female, 7 male; $M_{Age} = 44.25$ ($SD_{Age} = 3.79$)

Procedure: Caregivers explain 10 financial abstract concepts (e.g., inflation) in 80-seconds. Children select the corresponding picture from four options. After a break, children provide **definitions** and choose from a new picture array to test **generalisation**. This process is repeated **one week later (follow-up)**.

Transcription & Coding: Interactions are audio-recorded, transcribed using AI with manual checks, and coded using MAPS. Coding is conducted blind to the child's performance.

MAPS Codebook and Examples

Strategy	Subcategory	Examples
Explanations	2 nd person	" You are in debt when you spend more money than you have."
	Other (1 st / 3 rd person)	"A subsidy is something the government does to influence behaviour." "Debt is when I owe someone money."
Personal examples		"Like what the bad people did to Granny and Grandpa the other week where they stole their credit card. It was fraud."
Hypothetical examples	2 nd person	"[...] if you're the government and you want to encourage solar power, you might say, we'll give people a subsidy to make green power cheaper."
	Other (1 st / 3 rd person)	"Let's say the auctioneer is selling a painting. Somebody says, I'll pay £100 and then somebody else says, I'll pay £120."
Maintaining rapport / homeostasis		"You're doing really well. It's hard. You're doing really well." "How are you doing, chicken?"
Checking in for common ground		"Oh, okay, this word is taxation. Do you know what that means?"
Checking in for understanding	Explicitly	"You get it?"; "Yeah?"; "Isn't it?"; "Okay?"
	Implicitly	"And who wins an auction?"
Talking about pictures		"Do any of the pictures look like a job?"

Impact

Caregiver

- male (44) journalist diploma

Strategies

- both type of explanations, finding common ground, checking explicit and implicit understanding

Child

- girl (9y10m) average vocabulary (BPVS-3) average working memory (DS, WISC-IV)

Child's learning

- Generalisation main: 90%
- Generalisation follow-up: 90%
- Definition main: 45%
- Definition follow-up: 90%

female (43) academic doctoral degree

personal and hypothetical 2nd person examples building rapport talking about the pictures

girl (8y4m) high vocabulary (BPVS-3) above average working memory (DS, WISC-IV)

Child's learning

- Generalisation main: 80%
- Generalisation follow-up: 60%
- Definition main: 25%
- Definition follow-up: 45%

Next steps: Code all dyads using the MAPS codebook.

Regression analysis:

- ❖ teaching strategies ↔ child's learning outcomes;
- ❖ teaching strategies ↔ activation of the caregiver's mentalizing brain regions^{6,7} (e.g., dlPFC, TPJ)

Future Directions

- ✓ Broader application of the MAPS codebook in classroom and peer-to-peer learning contexts.
- ✓ Examination of how teaching strategies change with children's developmental stages and across different cultures.

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Acknowledgements: I am deeply grateful to Prof Peter Fonagy for his guidance on the development of the codebook, the members of the UCL Language and Cognition Lab for their invaluable feedback, and Guoda Trinkunaitė for her assistance with transcription.

Got 2 minutes for feedback? Scan this QR or use code **36 72 86 1** to join via Mentimeter.

dora.szegedi.20@ucl.ac.uk
[linkedin.com/in/dora-szegedi-a781a421b](https://www.linkedin.com/in/dora-szegedi-a781a421b)