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How is infants' attention distributed between agent and patient in causal events?

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Background

How preverbal infants perceive and process events can provide important insights into the conceptual foundations of language development (1).

Prelinguistic infants' event representations appear to closely reflect linguistic concepts, such as spatial relations or semantic roles, and recent research suggests that individual differences in infants' ability to categorise semantic components of events is predictive of later verb learning (2,3,4).

To establish mappings between event representations and the linguistic means of expressing them, infants must encode semantic components such as roles, identities, and causal relations between event participants (i.e. *who* is doing *what* to *whom*).

We explored infants' processing of two-participant causal events by measuring the distribution of looking towards agent and patient throughout events. Across three experiments we measure infants' responses to changes in the **action (E1)**, the **identity (E2)** and **animacy (E3)** of agent and patient in events, and how each of these might interact with **thematic roles**.



Figure 1. Screenshots of typical stages in each 10 second animated event. NB. An online demo animation can be viewed at **bit.ly/jackson_animation**



Figure 2. Proportions of looking towards agents in each experiment, plotted over time. Shaded areas represent periods of statistically significant (p<0.5) divergences between conditions. Dotted vertical lines represent markers of stages within events; the first and third lines, at 2 seconds and 6 seconds respectively, represent the onset and offset of motion of event participants; the middle vertical line, at 4 seconds, represent the point where the agent first makes physical contact with the patient in each event.

Method

Participants

- 13-month old English-learning monolinguals.
- All completed the experiments in the same order, over two visits.
- 51 infants tested on all three experiments, with final samples of n = 41 (E1), n = 32 (E2), and n = 42 (E3).

Stimuli

- 10-second, silent animations of 2-participant causal interactions.
- All matched for the onset, offset, and range of movement shown (see Fig. 1).

Procedure

- Eye tracking used to record looking behaviour.
- Infants were familiarised with repeated examplars of an event before being presented with four randomly-ordered test trials.
- Test trials consisted of a 2x2 factorial combination of thematic role (Novel vs Familiar) and each experiment's isolated component,

Results

Proportion of looking collapsed over trials.

Experiment 1

- Significant effect of **action**, but not of **role**, or the interaction.
- Infants had a slight tendency to look more to patients in events containing novel actions.

Experiment 2

- Significant effect of **identity**, but not of **role**, or the interaction.
- Infants looked more to the novel participant in events regardless of the thematic role that participant occupied.

Experiment 3

- Significant effect of **role**, but not of **animacy**, or the interaction.
- Infants looked more to the novel participant in events, regardless of the animacy of either participant in those events.



Discussion

Analyses of looking proportions collapsed over whole trials suggests that infants are sensitive to changes in the **action** performed in causal interactions, and to changes in **identities** of both the agent and the patient. No evidence of sensitivity to the **animacy** of the participants was found, and we observe only limited evidence of sensitivity to reversals of **thematic roles** in events.

Examining looking proportions over time however provides greater insight into the dynamics of infants looking within events as they unfold.

When infants are presented with a causal interaction between familiar participants they demonstrate a significant bias towards patients if the interaction contains a novel **action**.

When the **identities** of agents and patients are manipulated, infants look significantly more to novel participants in events, regardless of the previous role of the novel participant. Differences in looking are only observed in the static phases of events however (i.e. outside of the animated causal interaction) suggesting that infants do not generalise learned thematic roles to novel interactions.

action, identity, or animacy.

Analysis

- Two regions of interest, agent and patient.
- Analyses of proportion of looking to each participant.
- Linear mixed effects models performed for each experiment.
- Fixed effects: **Thematic role** and each experiment's isolated component. Random effects: by-participant intercepts and random slopes for each of the fixed effects.

References

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(Intercept)	0.40	30.04	
Action	-0.05	-2.15	0.03*
Thematic Role	0.001	0.17	0.86
Action * Thematic Role	-0.08	-1.63	0.10
Experiment 2			
(Intercept)	0.45	44.13	
Identity	0.15	5.00	<0.01***
Thematic Role	0.01	0.54	0.59
Identity * Thematic Role	-0.05	-1.33	0.19
Experiment 3			
(Intercept)	0.44	33.21	
Animacy	-0.02	-0.66	0.51
Thematic Role	-0.20	7.16	<0.01***
Animacy * Thematic Role	0.04	0.97	0.34

Table 1. Mixed models for proportions collapsed over trials.

By examining changes in looking proportions over time, we can gain greater insight into the dynamics of infant looking within events as they unfold (see Fig.2). When the **animacy** of the event participants is manipulated there appears to be a significant interaction between animacy and role; infants appear to be sensitive to reversals of the prototypical interaction of animate agent acting upon an inanimate patient.

Future work

- Explore individual differences, and incorporate language (UK-CDI) and behavioural data (Bayley Scales).
- Longitudinal language-focussed follow-up at 2 years of age do individual differences predict later language abilities?



