Children's Interpretation of the Function Words *and* & *with*
An Eyetracking Investigation

Tom Fritzsche[1], Yarden Kedar[2], Barbara Höhle[1] & Dana David[3]
[1] University of Potsdam, Germany, [2] The Center for Academic Studies, Israel, [3] Ben-Gurion University of the Negev, Israel

Function words as cues in early language acquisition

Detection and Segmentation
- At 6 months: French determiners (la, des) in NPs (Shi, Marquis & Gauthier, 2006)
- At 8 months: German function words (FWs) in sentences (Höhle & Weissenborn, 2003)
- At 8 months: use of high frequency determiners for segmenting novel nouns (Shi et al., 2006)

Syntactic categorization and referent identification
- At 14-16 months: determiners are used to categorize novel words (Höhle et al., 2004)
- At 18 months: a correct determiner is expected (Kedar et al., 2006; Zangl & Fernald, 2007)
- At 25/36 months: the gender of a determiner is used in French (van Heugten & Shi, 2009), in Spanish (Lew-Williams & Fernald, 2007)

Research Question
At what age are FW used as structural markers that influence interpretation?

Nearly identical phrases can have different structures depending on the FW:

$$\text{NP } \textbf{FW} \text{ NP}$$

[NP] *and* [NP]

coordination of equal elements

[NP [*with* [NP]]]

embedding of on element into the other

Acquisition of *and* & *with*
- Both FW are present in the productive vocabulary of about half of all 2-year olds (CDI[1]: 40.7% for *and*, 63,6% for *with*)
- *and* is produced as connector at about 25 months (Bloom et al., 1980) and correct comprehension is attested for object NPs and VPs from 30 months (Ardery, 1980)
- *with* first appears in speech of English-learning children at 20/25 months (Kidd & Cameron-Faulkner, 2008; Tomasello, 1987)

Method
Participants
- 68 monolingual German children and 18 adults

Age Group	N	m/f	Age range
2-year olds	25	15/10	23.3 - 24.5
3-year olds	20	11/9	35.5 - 36.5
4-year olds	23	12/11	47.5 - 48.5
Adults	18	5/13	19 - 28 years

Material
- 8 complex noun phrases (NPs)
- Each complex NP could be presented with *and* or *with*

[NP$_1$] [*and*] [NP$_2$]

*ein Pulli **und** Autos
a sweater **and** cars*

[NP$_1$ [$_{PP}$ *with* [NP$_2$]]]

*ein Pulli **mit** Autos
a sweater **with** cars*

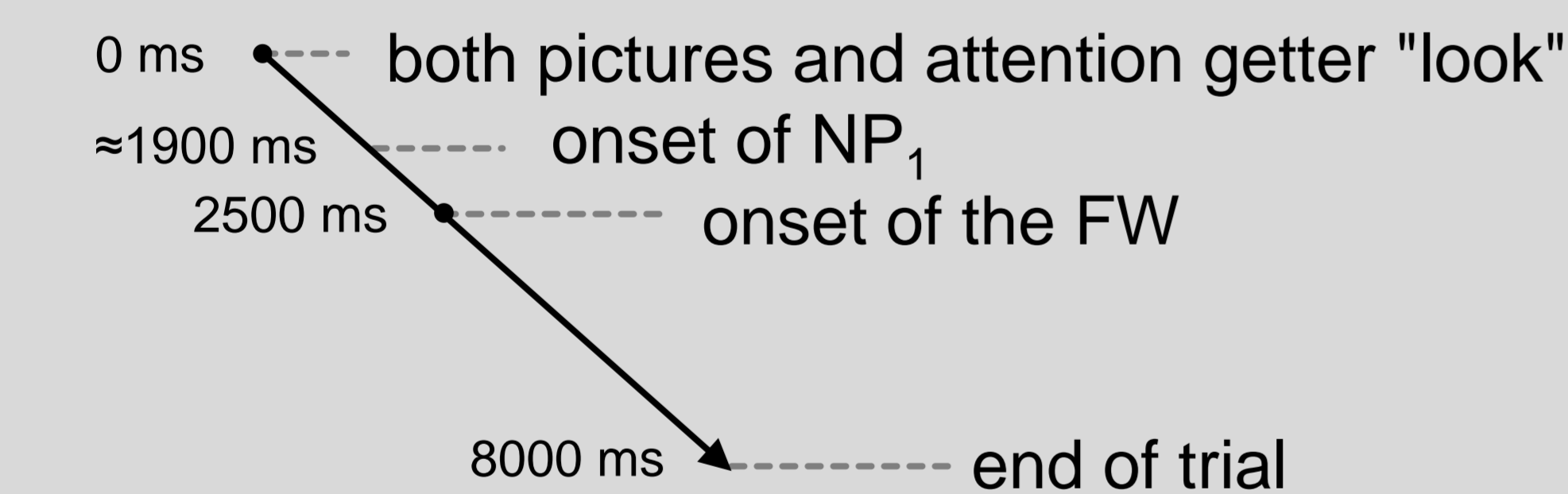| NP$_1$	NP$_2$
sweater	cars
blanket	lions
pillow	monkeys
jar	candy
box	cakes
truck	pears
dress	flowers
doll	socks

2-referent picture   **1-referent picture**

- The associated meaning was depicted in colored line drawings with either one or two referents (NB: the *with* phrases are consistent with both pictures)

Procedure
- 8 trials per participant with an attention getting cartoon character after every other trial
- FW-NP pairing was varied across participants
- No response was required, instruction "Just look at the pictures"
- Course of a trial

    0 ms --- both pictures and attention getter "look"
    ≈1900 ms --- onset of NP$_1$
    2500 ms --- onset of the FW
    8000 ms --- end of trial

Apparatus
- Tobii T120 eyetracker (tracking rate: 60 Hz), with a 17" monitor
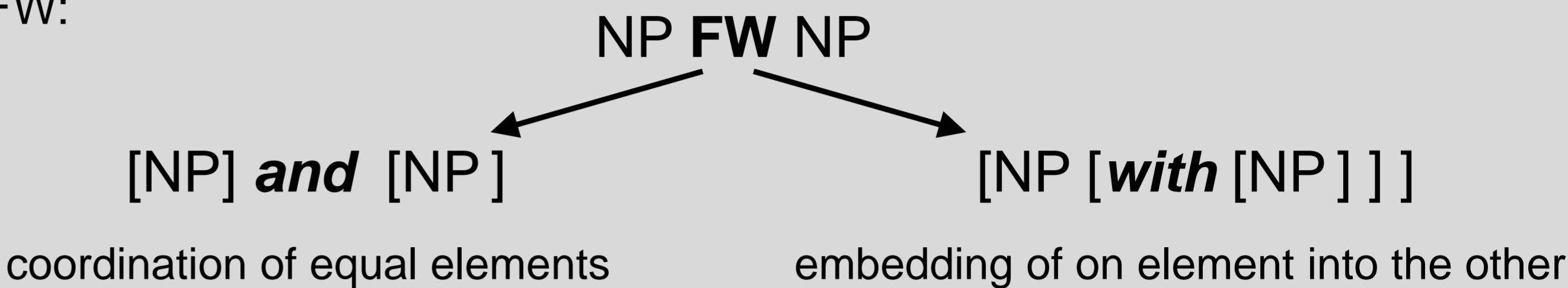- Presentation software: Tobii Studio
- 5-point calibration

Predictions
1. Upon hearing the FW, looks shift to the corresponding picture in adults:
   and: towards the 2-referent picture, *with*: away from the 2-referent picture
2. All age groups show a similar gaze pattern as adults, however with a developmental trend in which performance becomes better as age increases.

Results
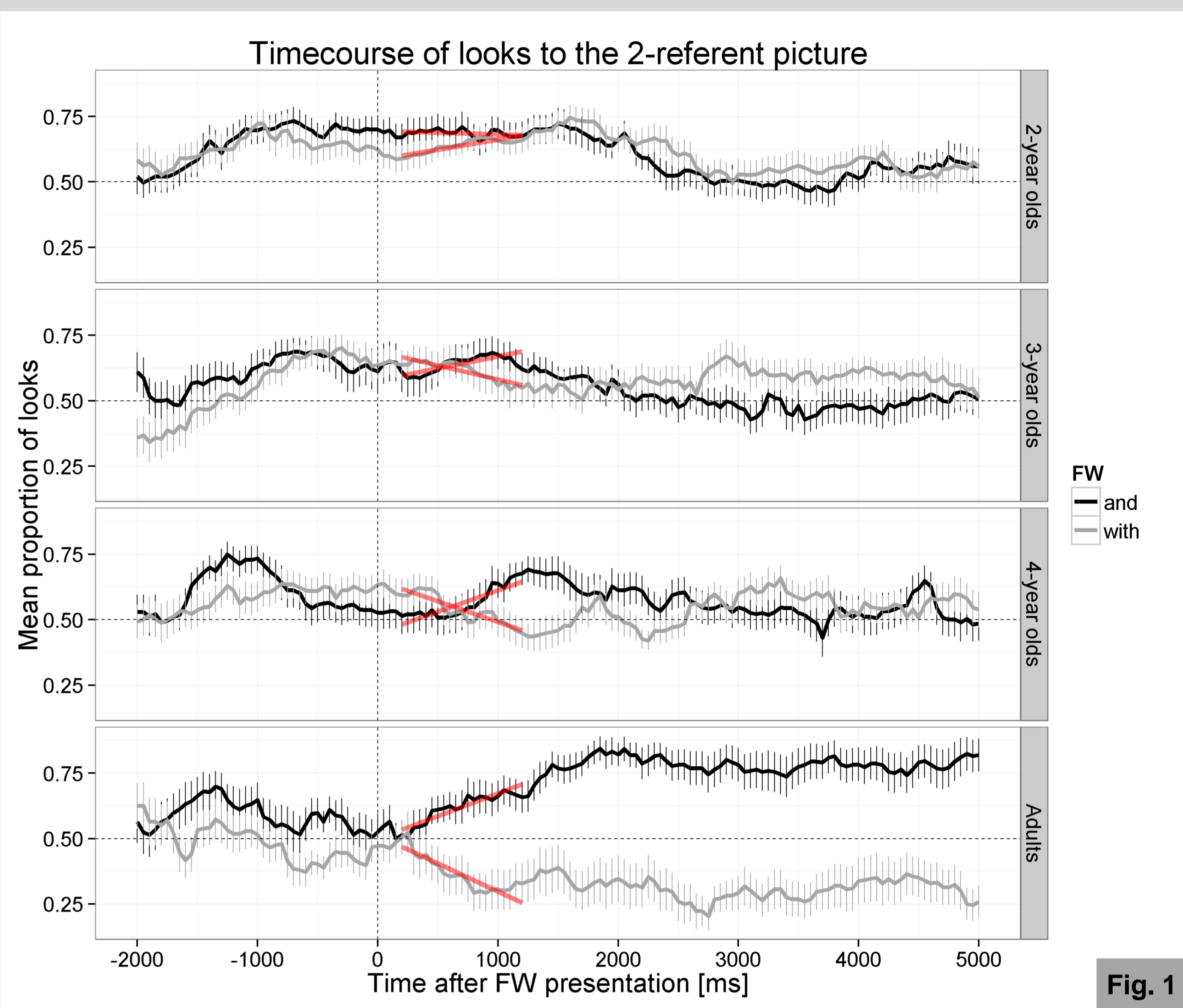

Fig. 1

Timecourse of looks to the 2-referent picture

Proportion analysis
- Aggregation of gazes to the 2-referent picture relative to both pictures (Fig. 1)
- Anova of 1s windows after FW presentation with the factors Age, Fw and Window: all factors are significant ($p<.05$), also the 3-way interaction ($p<.0001$)
- Single comparisons reveal sign. differences ($p<.05$) for the adults throughout, for 4-year olds between 1-2s and for 3-year olds between 3-4s (unexpectedly in the opposite direction)

Slope analysis
- The slope to the 2-referent picture was calculated for each participant in a 1s period following the FW onset (with a 200 ms latency) by a linear regression (red line in Fig. 1)
- Anova of the slope values (Fig. 2)
  - No effect of Age($p=.935$), but for Fw ($p<.001$) and the 2-way interaction ($p<.01$)
- Single comparisons show that the Fw effect is present in 3- and 4-year olds and in adults (p's$<.05$)
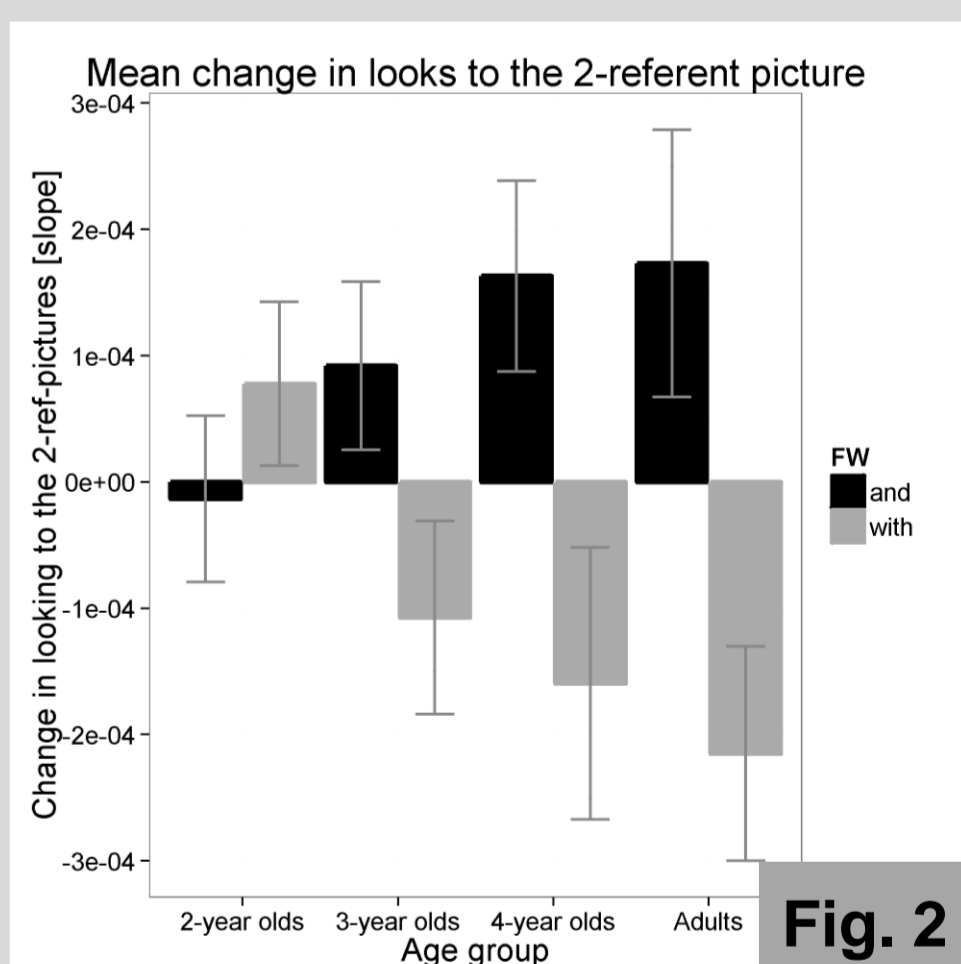

Fig. 2

Mean change in looks to the 2-referent picture

Summary
- Regarding the predictions: 1. confirmed , 2. confirmed, except for 2-year olds
- Adults' gaze proportions are clearly influenced by the FW of the phrase
  - The effect is quick and sustained (until the end of the trial)
- 2-year olds' looking behavior seems to be unaffected by the FW while they show a general preference for the 2-referent picture
- In 3- and 4-year olds there is a developmental change towards the adult pattern
  - The proportion analysis reveals a short effect only for 4-year olds that occurs later compared to adults, he slope analysis shows an immediate influence on shifting looks to the 2-referent picture already at 3 years

Conclusion
We present data that at the age of 3 years children use the structural properties of the FWs *and* and *with* to construct the meaning of complex noun phrases. 2-year-old children do not display this ability.
The influence of the FWs on the looking behavior occurs within the first second after the onset of the FW and is very similar in 3-year olds, 4-year olds, and adults (slope analysis).
Clear preferences could only be shown for a short 1s-window in 4-year olds (proportion analysis).
The long-lasting effect in adults is probably due to strategic looking behavior as they became aware of the purpose of the study.
While most 2-year olds already produce these FWs (although it is no clear in which structures), they are not yet able to differentiate the subtle differences in meaning between *and* and *with* in our task, where both phrases where grammatical and the contrast between them was very small.

Contact: *tom.fritzsche @uni-potsdam.de*

References & Notes
Shi, Marquis & Gauthier, 2006, Proc BUCLD 30, 549-560.
Shi, Cutler, Werker & Cruickshank, 2006, J Acoust Soc Am, 119, 61-67.
Höhle & Weissenborn, 2003, Developmental Sci, 6, 122-127.
Höhle, Weissenborn, Kiefer, Schulz & Schmitz, 2004, Infancy, 5, 341-353.
Kedar, Casasola & Lust, 2006, Child Dev, 77, 325-338.
Zangl & Fernald, 2007, Lang Learn Dev, 3, 199-231.
van Heugten & Shi, 2009, Developmental Sci, 12, 419-425.
Lew-Williams & Fernald, 2007, Psychol Sci, 18, 193-198.
Bloom, Lahey, Hood, Lifter & Fiess, 1980, J Child Lang, 7, 235-261.
Ardery, 1980, J Child Lang, 7, 305-320.
Kidd & Cameron-Faulkner, 2008, Linguistics, 46, 33-61.
Tomasello, 1987, J Child Lang, 14, 79-98.

[1] German CDI: Grimm & Doil, 2006, ELFRA, Göttingen: Hogrefe.