

Binding pronouns to discourse referents introduced with pointing gestures

Cornelia Ebert, Kurt Erbach, and Magnus Poppe

The question of how features of the anaphoric pronouns are established is complicated in copula constructions when referring to antecedents that have not been lexically articulated, but rather have been articulated via gesture and therefore involve a mismatch between linguistic modality. We report results of experiments on pronoun binding across modalities and compare it to those on binding within the written modality. We show that dynamic binding of pronouns across modalities is possible, marked when the pronoun’s grammatical gender does not agree with the unspoken predicate, and that these patterns are similar to what we see for written language alone. These results can be captured with a formal framework for gesture semantics where co-speech pointing gestures introduce discourse referents (DRs) that can serve as antecedents in anaphoric reference, which this necessitates a unidimensional dynamic system that allows for binding effects across dimensions and, in this case, modalities (e.g. Ebert et al. 2020).

Experimental design. We ran two cross-modal and one written experiment, each with a 2x2 design. In all experiments, the first factor was DR (introduced vs. not-introduced). In the first multi-modal experiment (*MM1*) and the written experiment (*W*) the second factor was PRONOUN (present vs. absent), while in the second multi-modal experiment (*MM2*) the second factor was PRONOUN (agree vs. disagree); see Table 1. In the multi-modal experiments, the DR-introduced condition is realized by presenting participants with a video in which a sentence is uttered with pointing co-speech gesture pointing to a visible object—e.g. pointing to a piece of cake when uttering *eaten* (1-a)—thereby introducing the object as a DR. In the written experiment, DR-present is a written correlate to the gestured sentence—e.g. the cake is explicitly mentioned (2-a). The DR-not introduced condition is realized in the multi-modal experiment with the same utterance as DR-present but with a gesture not-pointing to a discourse referent—e.g. placing a hand over the stomach when uttering *eaten* (1-c). The written experiment again has a written correlate—e.g. the cake is not mentioned (2-b).

In a variation of the covered-box task (cf. Fanselow et al. 2022), participants were instructed to select the best PRONOUN follow-up to a DR utterance from a pair of alternatives, where one is visible in written form, e.g. (1-b), and the other is ‘covered’ (lit. “[geschwärzt]” (‘redacted’)). German was the base language of the experiments, so each pronoun’s grammatical gender was chosen based on the most likely used predicate for the pointed to object—e.g. *Er* (PRO.M.NOM) to agree with *der Kuchen* ‘the_M cake_M’ in the parallel items to (1-a)+(1-b). Following a DR-introduced condition, PRONOUN-present/agree conditions are assumed to be felicitous—e.g. *MM1/2*: (1-a)+(1-b); *W*: (2-a)+(1-b);—and therefore to be accepted by participants, under the assumption that pronouns can bind to pointed-to DRs. Following a DR-not introduced condition, PRONOUN-present/agree conditions are assumed to be infelicitous—e.g. *MM1/2*: (1-c)+(1-b); *W*: (2-b)+(1-b);—and therefore to not be accepted by participants, under the assumption that there is nothing for the pronouns to bind to.

In the first multi-modal experiment and in the written experiment, PRONOUN-absent was realized with a follow-up that would presumably be accepted after the DR-not introduced utterance—e.g. *MM1*: (1-c)+(1-d); *W*: (2-b)+(1-d). Conversely, PRONOUN-absent might not be accepted after the DR-introduced utterance—e.g. *MM1*: (1-a)+(1-d); *W*: (2-a)+(1-d)—given it ignores the DR.

In the second multi-modal experiment, PRONOUN-disagree was realized by having a pronoun that does not agree in grammatical gender with the most likely used predicate for the pointed to object in the DR-introduced condition—e.g. *Sie* (PRO.F.NOM) not agreeing with *der Kuchen* ‘the_M cake_M’; cf. (1-a)+(2-c)—and presumably would not be accepted by participants. In the DR-not introduced–PRONOUN-disagree condition—e.g. (1-c)+(2-c)—participants would presumably not accept the follow-up containing a disagreeing pronoun.

Results. 80 participants per experiment were recruited via Prolific; we excluded those who failed 50% or more attention questions ($n=3$ for the first multi-modal experiment, $n=0$ for others) and the number of participants per list was made equal ($n=18$ for the first multi-modal experiment). In all of the experiments (Fig. 1), participants accepted follow-ups with agreeing pronouns after utterances in which DRs were introduced (1-a)/(2-a)+(1-b) more than equivalent contexts without such DR (1-c)/(2-b)+(1-b). Notably, rather than being outright rejected (e.g. $n<50$), the DR-not introduced–PRONOUN-present condition saw pronouns accepted closer to chance ($n_{multi-modal\ 1}=63/180$; $n_{multi-modal\ 2}=94/200$; $n_{written}=98/200$). As expected, the use of a pronoun is marked when there is no established DR in both the multi-modal and written experiments.

In multi-modal experiment 2, where the PRONOUN-disagree condition has pronouns that do not agree in grammatical gender with the predicate that is true of pointed to referent ((1-a)+(2-c)), the disagreeing pronoun was accepted near chance ($n=114/200$), which is similar to the parallel condition in multi-modal experiment 1 ($n=105/180$)—e.g. (1-a)+(1-d)—but very different from the parallel condition in the written experiment ($n=38/200$)—e.g. (2-a)+(1-b). This difference may be related to the not-at-issueness of co-speech gestures (Ebert et al. 2020)—i.e. whether the cake was eaten is not at-issue when the cake is only pointed to rather than overtly mentioned, so ignoring the cake seems to be more acceptable when only pointed to as opposed to when it is overtly/lexically mentioned.

The results were analyzed with a mixed-effects model with binomial error distribution constructed in R (R Core Team 2015) using the lmerTest package (Kuznetsova et al. 2019). The main effect of DR–PRONOUN interaction is statistically significant for multi-modal experiment 1 ($p = 0.00260$) and the written experiment ($p = 9.26e-15$). In the pronoun dis/agreement experiment, multi-modal 2, this interaction was not significant, but an ANOVA between models with an without agreement suggests there is an effect of an agreement ($p = 0.01816$).

Discussion. These results are taken to support formal analyses of gesture and anaphora that use a unidimensional system allowing binding effects across dimensions (e.g. Ebert et al. 2020). At the same time, the near-chance acceptance of PRONOUN-present items in the DR-not introduced contexts (as opposed to very low acceptance like pronoun-absent follow-ups to DR-introduced items in the written experiment), suggests that, there may be some repair at work. This necessitates further work looking at the discourse contexts in which pronouns are used, from objects in the physical space (e.g. visible, but not pointed to cake), to the lexical items used (e.g. transitive verbs like *eaten* with unbound arguments).

- | | |
|---|--|
| <p>(1) a. Have you <u>eaten</u>_{pointing to cake}?</p> <p>b. It was too sweet for me.</p> <p>c. Have you <u>eaten</u>_{hand over stomach}?</p> <p>d. Yeah, a few too many cookies.</p> | <p>(2) a. Have you eaten the cake?</p> <p>b. Have you eaten?</p> <p>c. She was too sweet for me.</p> |
|---|--|

DR	PRONOUN	Factor level	Examples
introduced	present _{MM1, W, agree_{MM2}}	felicitous	(1-a)+(1-b)
not introduced	present _{MM1, W, agree_{MM2}}	infelicitous	(1-c)+(1-b)
introduced	absent _{MM1, W, disagree_{MM2}}	infelicitous?	(1-a)+(1-d)
not introduced	absent _{MM1, W, disagree_{MM2}}	felicitous	(1-c)+(1-d)

Table 1: Experimental conditions

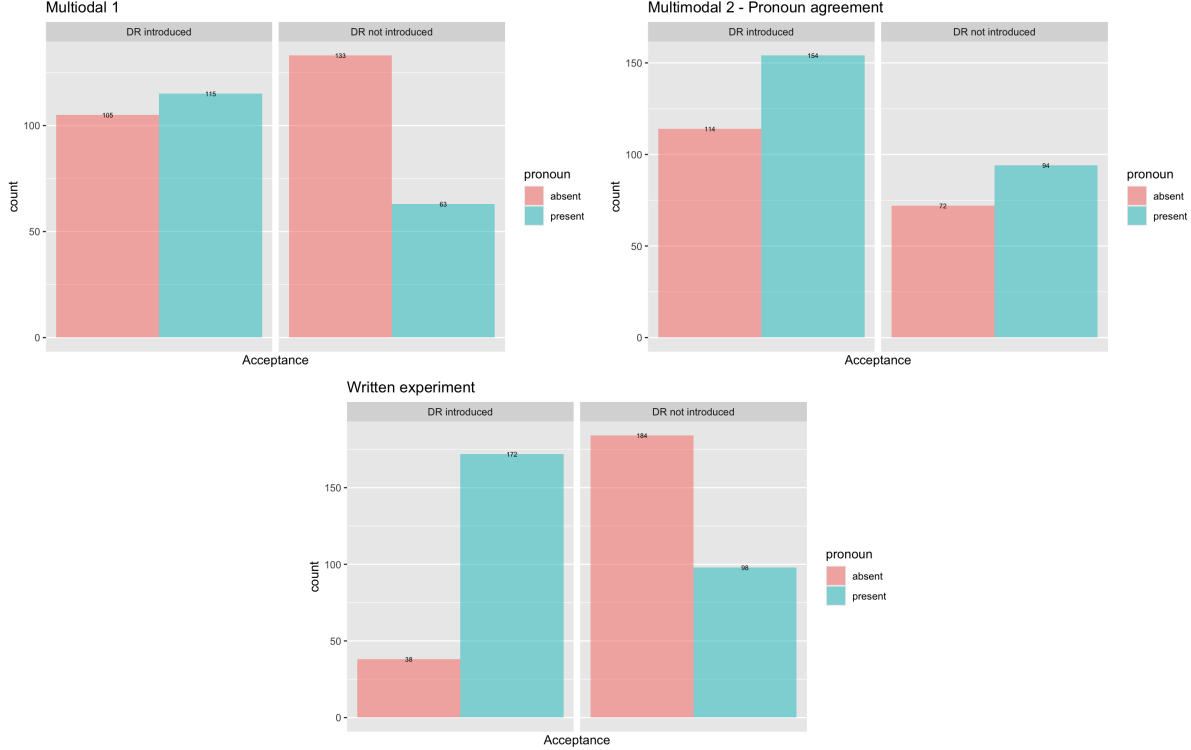


Figure 1: Top-left: Acceptance in multi-modal 1 (max=180). Top-right: Acceptance in multi-modal 2, pronoun agreement (max=200). Bottom: Acceptance in written design (max=200).

References

- Ebert, Christian, Cornelia Ebert & Robin Hörnig. 2020. Demonstratives as dimension shifters. In *Proceedings of sinn und bedeutung*, vol. 24 1, 161–178.
- Fanselow, Gisbert, Malte Zimmermann & Mareike Philipp. 2022. Accessing the availability of inverse scope in German in the covered box paradigm. *Glossa* 7(1).
- Kuznetsova, Alexandra, Per B. Brockhoff & Rune H. B. Christensen. 2019. ‘*lmerTest*’ *r* package version 3.1-0. <https://cran.r-project.org/web/packages/lmerTest/index>.
- R Core Team. 2015. *R: A language and environment for statistical computing*. Foundation for statistical computing. <http://www.R-project.org/>.