Cross-linguistic Influence Online: An Eye-Tracking Study on Pronoun Resolution in Simultaneous Bilingual Turkish-Dutch Children

Chantal van Dijk, Anna Aumeistere, Susanne Brouwer, Ton Dijkstra, and Sharon Unsworth

1. Introduction

It is well-known that bilingual children's morphosyntactic systems can influence each other (Serratrice, 2013). For example, an Italian-English bilingual child may use an overt instead of a null pronoun in Italian under influence of English (e.g., Serratrice, Sorace, & Paoli, 2004). Such cross-linguistic influence has mainly been studied in children's production and sentence judgements (van Dijk et al., 2021). Few studies have investigated cross-linguistic influence in children's offline sentence interpretations and, to an even lesser extent during real-time sentence processing (online; cf. Lemmerth & Hopp, 2019; van Dijk, Dijkstra, & Unsworth, accepted). The goal of this study was, therefore, to investigate cross-linguistic influence in Turkish-Dutch children's online and offline comprehension of Dutch pronouns using an eye-tracking and picture selection task.

In non-null subject languages, like Dutch, a pronoun usually refers back to the most accessible referent in the discourse, often the discourse topic (e.g., Ariel, 2014; Cardinaletti & Starke, 1999). The Dutch pronoun *zij* ("she") in (1) therefore refers to the local referent *Anna* (e.g., Roberts, Gullberg, & Indefrey, 2008). Syntactic information can support or override discourse preferences (e.g., Tyler, 1983). For example, in (2) the feminine pronoun *zij* ('she') can only refer to *Anna* and the masculine pronoun *hij* ("he") only to the disjoint referent *Thomas*.

(1) Anna_i en Sophie_k leren in de bibliotheek.
Anna$_i$ and Sophie$_k$ study in the library
Terwijl Anna_i een boek leest, neemt $\text{zij}_{i/?k}$ een slokje water.
while Anna_i a book reads takes $\text{she}_{i/?k}$ a sip water
'Anna and Sophie are studying in the library. While Anna is reading a book, she takes a sip of water.'

*Chantal van Dijk, Centre for Language Studies, Radboud University, chantal.vandijk@ru.nl. Anna Aumeistere, Donders Institute for Brain, Cognition and Behaviour, Radboud University. Susanne Brouwer, Centre for Language Studies, Radboud University. Ton Dijkstra, Donders Institute for Brain, Cognition and Behaviour, Radboud University. Sharon Unsworth, Centre for Language Studies, Radboud University.

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(2) Anna$_i$ en Thomas$_k$ leren in de bibliotheek.
Anna$_i$ and Thomas$_k$ study in the library
Terwijl Anna$_i$ een boek leest, neemt zij$_{i/*k}$ / hij$_{*i/k}$ een slokje water.
while Anna$_i$ a book reads takes she$_{i/*k}$ he$_{*i/k}$ a sip water
'Anna and Thomas are studying in the library. While Anna is reading a book, he takes a sip of water.'

In Turkish, a null subject language, overt pronouns usually signal a shift in topic or emphasize their antecedent (e.g., Azar & Özyürek, 2015; Enç, 1986). Hence, in the Turkish translation of (1) with the pronoun *o* ("she/he") it would be pragmatically infelicitous for *Anna* to be the antecedent. Instead, the overt pronoun should refer to a non-topic antecedent: *Sophie* or an unmentioned person.

Children show cross-linguistic influence in their pronoun use and interpretations from a non-null subject language into a null subject language (e.g., Argyri & Sorace, 2007; Serratrice, 2007; Serratrice et al., 2004). Cross-linguistic influence can be explained in terms of co-activation during language processing and priming (e.g., Nicoladis, 2006; Serratrice, 2007, 2016; Sorace & Serratrice, 2009). Following such accounts, pronoun preferences in children's languages compete for activation during processing, sometimes resulting in the selection of a preference from the language not in use (i.e., an overt instead of a null pronoun in a null subject language; e.g., Sorace & Serratrice, 2009). Exposure to overt pronouns in one language can also prime the use of overt pronouns in another language over time (e.g., Serratrice, 2007). Furthermore, cross-linguistic influence has been found to be stronger from children's dominant into their weaker language than vice versa (van Dijk et al., 2021).

Cross-linguistic influence from a null subject language in (online) pronoun interpretations in a non-null subject language has been investigated in adult second language (L2) learners (e.g., Cunnings, Fotiadou, & Tsimpli, 2017; Roberts et al., 2008; Schimke, de la Fuente, Hemforth, & Colonna, 2018), but not in children. The available studies show mixed effects. Schimke et al. (2018) found evidence for online and offline cross-linguistic influence in adults' pronoun interpretations in their L2, German – a non-null subject language – from their first language (L1), Spanish – a null subject language. Roberts et al. (2018) observed influence from Turkish on Dutch L2 learners' offline judgements of Dutch pronouns, but not on their online behaviour (eye-movements). Instead Turkish-L1 and German-L1 L2 learners of Dutch behaved differently online from Dutch native speakers regardless of the properties of their L1, suggesting that processing pronouns in a L2 is less efficient than in a L1. Cunnings et al. (2017) also observed a general negative L2 processing effect on adults' pronoun interpretations. In a similar vein, a more general bilingualism effect has been proposed as alternative explanation for pronoun production and offline comprehension in bilingual children (Sorace, Serratrice, Filiaci & Baldo, 2009).

We asked whether a null subject language – Turkish – influences online and offline pronoun interpretations in Dutch in Turkish-Dutch bilingual children and to what extent such cross-linguistic influence was modulated by language

dominance. We hypothesized that if morphosyntactic properties of bilingual children's languages are co-activated during sentence processing (e.g., Nicoladis, 2006; Sorace & Serratrice, 2009), Turkish-Dutch children should be more likely than Dutch monolingual children to associate Dutch overt pronouns with a non-topic interpretation. This is in line with studies with L2 learners (e.g., Roberts et al., 2008; Schimke et al., 2018). Furthermore, following co-activation accounts, cross-linguistic influence offline should be a weaker reflection of cross-linguistic influence online (e.g., van Dijk et al., accepted). Hence, we predicted cross-linguistic influence to be more pronounced online than offline. Finally, we expected cross-linguistic influence to become stronger with increasing Turkish-dominance, following offline studies with children (e.g., van Dijk et al., 2021).

Following Roberts et al. (2008) we included control groups of Dutch monolingual and German-Dutch bilingual children. If cross-linguistic influence is at play in children's pronoun interpretations, Turkish-Dutch children were expected to behave differently from the control groups. If, instead, general bilingualism effects are at play, we expected the Turkish-Dutch and German-Dutch group to behave similarly, but differently from the monolinguals.

2. Method

2.1. Participants

Participants were 17 Turkish-Dutch (age: *M* = 9.1; *SD* = 1.2) and 22 German-Dutch bilingual (age: *M* = 8.8; *SD* = 1.2) and 14 Dutch monolingual children (age: *M* = 8.2; *SD* = 0.9), all living in the Netherlands and were 7-to-10 years old.[1] Children's had acquired Turkish/German since birth and Dutch before 3;0.

Using a parental questionnaire (*Bilingual Language Exposure Calculator*; Unsworth, 2013) we calculated two dominance measures: (i) children's cumulative input with children's relative Turkish/German exposure since birth (Turkish: *M* = 39.2%; *SD* = 13.7; range = 12.9–67.7; German: *M* = 43.5%; *SD* = 11.1; range = 22.2–65.8) and current input with children's average daily exposure in Turkish/German relative to Dutch (Turkish: *M* = 28.9%; *SD* = 8.8; range = 12.4–42.3; German: *M* =34.6%; *SD* = 14.1; range = 9.4–59.2).

2.2. Eye-tracking task

2.2.1. Materials and procedure

We created 36 triplets of short stories with a pronoun (i) disambiguated by gender towards the local interpretation (2; local condition); (ii) disambiguated towards the disjoint interpretation (2; disjoint condition); or (iii) ambiguous for a local or disjoint interpretation (1; optional condition). Half of the pronouns were feminine (*zij*; "she") and half masculine (*hij*; "he"). To increase the pragmatic

[1] Group sizes are smaller than intended because testing had to be postponed due to Covid-19.

acceptability of a disjoint reading, we used strong pronouns only (e.g., Kaiser, 2011). A question targeting children's offline pronoun interpretations followed each story (e.g., *Wie nam een slokje water?* "Who took a sip of water?").

A Dutch female native speaker recorded the sentences using neutral intonation. We aligned the onset of the subordinate clause (*M* = 4108ms; *SD* = 73.4), the main clause (*M* = 7066ms; *SD* = 3.6), the pronoun (*M* = 7677ms; *SD* = 12.6) and material after the pronoun (*M* = 8217ms; *SD* = 16.6) in Praat (Boersma & Weenink, 2018). We created three different lists in which every story appeared only in one version. The order of the stories in each list was pseudo-randomized such that children in each language group listened to different lists. Experimental items were interspersed with 36 fillers without pronouns with different characters including 9 encouragements. Comprehension questions followed fillers to ensure that children were paying attention. Stories were accompanied by pictures of the characters involved on a laptop screen (Figure 1). Characters' names were written on their clothes. A picture of a third object mentioned in the subordinate clause was displayed underneath the characters. The order of the characters in the sentences and on screen was counterbalanced between items.

Each child listened to 36 experimental and 36 fillers items through headphones. A Tobii pro camera (120 Hz) attached below the laptop screen recorded their eye-movements. The experiment started with a calibration procedure to control for drifts. Pictures were displayed from the story onset until 750ms after the offset. Only the two characters were shown during the comprehension questions. Children selected a character by pressing a button. The task started with 4 practice items and took about 40 minutes in total.

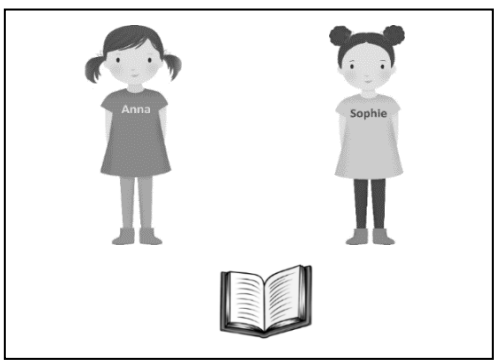


Figure 1. Example of visual stimuli in eye-tracking task in optional condition.

2.2.2. Scoring & data preparation

We coded children's looks at the local or disjoint character, or object for each 8ms time frame. These data were then aggregated in 40ms time bins. For each time bin we calculated differentials between children's fixations on the local and disjoint referent by subtracting the empirical logit transformed (e.g., Barr, 2008)

proportions of fixations at the disjoint referent from the local referent. To explore early and later preferences for the local and disjoint referent (e.g., Arnold et al., 2007; Song & Fisher, 2005), we defined two time windows of interest starting from the pronoun onset: (i) a pronoun window including 200ms after pronoun offset due to the planning of a saccade (0ms-740ms; Matin, Shao, & Boff, 1993); and (ii) a post-pronoun window (740ms-2000ms).

Children's offline referent choices were coded as 1 (local) or 0 (disjoint).

2.3. Background tasks

Cross-linguistic lexical tasks (CLTs) from the LITMUS-battery measured children's productive vocabulary in their languages (Haman, Łuniewska & Pomiechowska, 2015; Rinker & Gagarina, 2017; Ünal, Tunçer & Ege, 2012; van Wonderen et al., 2017). In each task, children named 60 pictures. We calculated the percentage of correctly-named items (Table 1; based on Bohnacker, Lindgren and Oztekin, 2016). To obtain a third dominance score we subtracted Dutch scores from Turkish scores. Children's relative proficiency ranged from Dutch-dominant to balanced (M = 19.8; SD = 23.9; *range* = -71-12). Difference scores correlated with the Dutch (Pearson's $r(16) = -.52$; $p = .037$), and the Turkish CLT scores (Pearson's $r(16) = 0.94$; $p < .001$).

Digit span tasks measured children's short-term and working memory capacity (Automated Working Memory Assessment; Alloway, 2012).

Table 1. Groups' average scores on CLTs (means, SDs, and ranges).

		Turkish-Dutch	German-Dutch	Dutch	Statistics
CLT	Dutch (%)	81.7 (8.5)[a] 68–95	92.6 (6.5)[b] 67–100	89.4 (5.2)[b] 82–100	$F(2, 50) =$ 12.1; $p <.001$
	Turkish/ German (%)	61.1 (20.9)[a] 14–88	82.5 (13.7)[b] 43–97		$t(24.5) = 3.6$; $p = .002$

Note One-way ANOVAs and independent t-tests for group comparisons. Different superscripts indicate significant differences between groups (Tukey's post-hoc tests).

2.4. Procedure

The bilingual children were tested at home or online during a Dutch and a Turkish/German session by trained (near-)native speakers of the test languages. Due to Covid-19, the second session with 1 German-Dutch and 1 Turkish-Dutch child had to be cancelled and no dominance scores were calculated. The Dutch task order was: eye-tracking, CLT, and digit span (~75 minutes). The Turkish/German CLT was part of a larger test battery in the second session (~60 minutes), not reported here. Families received a €15,- voucher for participation. Monolingual Dutch children participated in the Dutch session only and were tested at school or at the university. They received a small gift for their participation. Parents gave written consent for their children to participate.

2.5. Data analyses

Children's responses were analysed in R studio (version 4.0.3, R Core Team, 2020), using linear mixed models (lmms) for differential fixations and generalized lmms for local referent choices (lme4 package, 1.1-23, Bates, Maechler, Bolker, & Walker, 2015; lmerTest package, 3.1-2, Kuznetsova, Brockhoff, & Christensen, 2017). We created base models including fixed effects of *trial number* and background variables (*age*, *digit span forward* and *backward*, *Dutch CLT score*), and random intercepts by *participant* and *item*.[2] Continuous variables were grand-mean centred. Random slopes were not included in any model nor random intercepts by item in the generalized models due to convergence errors.

First, for children's fixations we added fixed effects of *group*, *time window*, and their interaction in a step-wise fashion in separate models of the three conditions. When the interaction was significant, *time window* was re-levelled to investigate *group* effects within the two time windows. For children's offline choices we added fixed effects of *condition*, *group*, and their interaction in a step-wise fashion. *Group* was Helmert contrast coded to test for cross-linguistic influence (Turkish-Dutch = 2/3; German-Dutch = -1/3; Dutch monolingual = -1/3), and for a bilingualism effect (German-Dutch = -1/2; Dutch monolingual = 1/2). For children's offline choices, we used Helmert contrasts to compare children's local referent choices in the disjoint (2/3) to the local (-1/3) and optional condition (-1/3), and in the local (1/2) to the optional condition (-1/2).

Second, we tested for effects of language dominance in separate analyses for the Turkish-Dutch children only. First, we added the main effect of each dominance variable to a model with the fixed effect of *time window* and in a second step we tested for their interactions between *time window*. Because of reasons of space, we only report on effects of *relative proficiency*. Patterns for *current* and *cumulative input* were similar, but did not always reach significance.

The significance of effects and interactions in all models was tested by comparing the fit of models with and without the effect or interaction of interest using likelihood ratio tests. When possible, model stress was reduced by removing absolute standardized model residuals above 2.5.

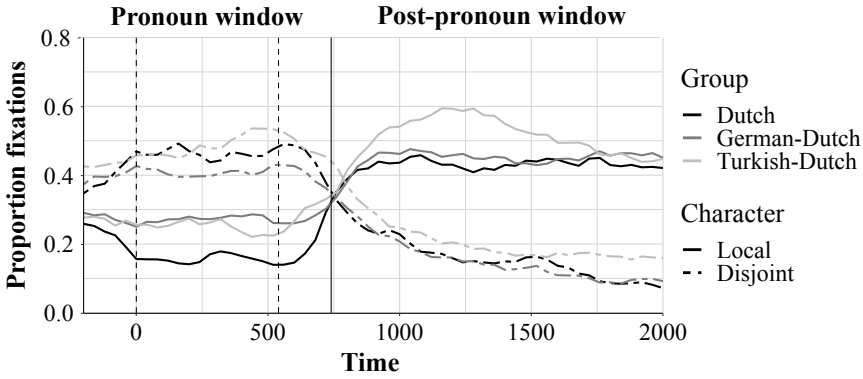
3. Results

3.1. Online pronoun resolution (eye-tracking data)

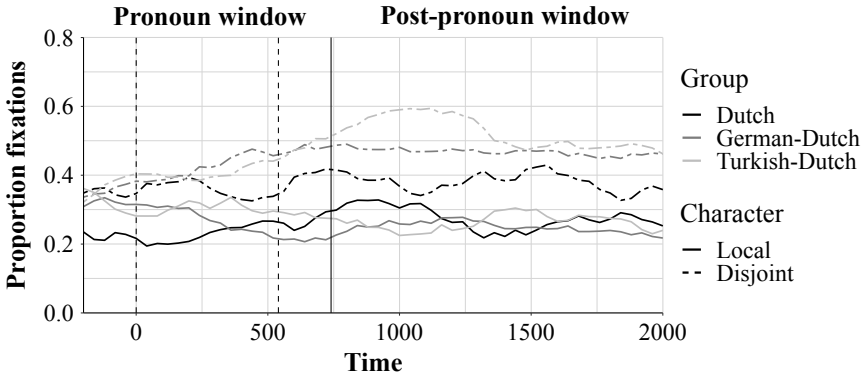
Figure 2 shows the average proportion of children's fixations on the local and disjoint character over time in the local, disjoint and optional conditions. The time window plotted is -200 ms before and 2000 ms after the pronoun onset.

[2] Non-significant background variables were dropped from the models.

A. Local condition



B. Disjoint condition



C. Optional condition

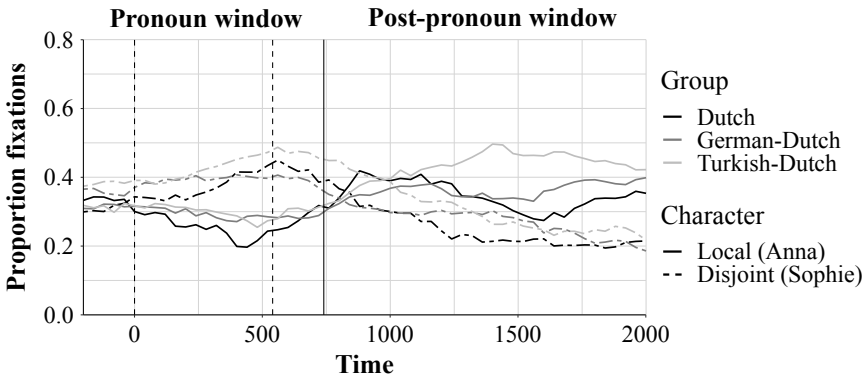


Figure 2. Average proportion of fixations in the three conditions for the three participant groups. The dotted vertical lines indicate the average pronoun onset and offset and the solid vertical line divides the two time windows.

Analyses of children's fixations in the local condition showed a non-significant effect of *group* ($X^2 = 3.0$; $\Delta df = 2$; $p = .228$), a significant effect of *time window* ($X^2 = 2722$; $\Delta df = 1$; $p < .001$) and a significant interaction ($X^2 = 49$; $\Delta df = 2$; $p < .001$). Children looked significantly more at the disjoint than the local referent in the pronoun window ($B = -0.96$; $SE = 0.13$; $t = -7.2$; $p < .001$) and vice versa in the post-pronoun window ($B = 1.26$; $SE = 0.13$; $t = 9.6$; $p < .001$). In the pronoun window, the German-Dutch children looked significantly more at the local than the disjoint referent than the monolingual children ($B = -0.86$; $SE = 0.26$; $t = -3.3$; $p = .002$). To explore this group difference, we re-ran the model with different contrasts. In the pronoun window the two bilingual groups looked significantly more at the local than the disjoint referent than the monolinguals ($B = -0.61$; $SE = 0.24$; $t = -2.6$; $p = .013$) and the German-Dutch group significantly more than the Turkish-Dutch group ($B = -0.50$; $SE = 0.25$; $t = -2.0$; $p = .046$). Other group comparisons were not significant (pronoun window, Turkish-Dutch vs. others: $B = -0.07$; $SE = 0.23$; $t = -0.3$; $p = .747$; post-pronoun window: Turkish-Dutch vs. others: $B = 0.00$; $SE = 0.22$; $t = 0.0$; $p = .985$; German-Dutch vs. monolinguals: $B = -0.16$; $SE = 0.25$; $t = -0.6$; $p = .521$; bilinguals vs. monolinguals: $B = -0.12$; $SE = 0.23$; $t = -0.5$; $p = .604$; Turkish-Dutch vs. German-Dutch: $B = -0.09$; $SE = 0.24$; $t = -0.4$; $p = .721$).

Analyses of children's fixations in the disjoint condition showed a non-significant effect of *group* ($X^2 = 2.1$; $\Delta df = 2$; $p = .344$), a significant effect of *time window* ($X^2 = 29.9$; $\Delta df = 1$; $p < .001$) and a significant interaction ($X^2 = 31.7$; $\Delta df = 2$; $p < .001$). Children looked significantly more at the disjoint than the local referent in the pronoun ($B = -0.74$; $SE = 0.181$; $t = -4.4$; $p < .001$) and even more so in the post-pronoun window ($B = -0.98$; $SE = 0.180$; $t = -5.4$; $p < .001$). None of the simple interactions between group and time window of interest were significant (pronoun window, Turkish-Dutch vs. others: $B = -0.09$; $SE = 0.33$; $t = -0.3$; $p = .796$; German-Dutch vs. monolinguals: $B = 0.14$; $SE = 0.38$; $t = 0.4$; $p = .715$; post-pronoun window: Turkish-Dutch vs. others: $B = -0.59$; $SE = 0.33$; $t = -1.8$; $p = .074$; German-Dutch vs. monolinguals: $B = 0.42$; $SE = 0.37$; $t = 1.1$; $p = .268$).

Analyses of children's fixations in the optional condition showed a non-significant effect of *group* ($X^2 = 0.1$; $\Delta df = 2$; $p = .964$), a significant effect of *time window* ($X^2 = 547$; $\Delta df = 1$; $p < .001$) and a significant interaction ($X^2 = 11.6$; $\Delta df = 2$; $p = .003$). Children looked significantly more at the disjoint than the local referent in the pronoun window ($B = -0.55$; $SE = 0.17$; $t = -3.3$; $p = .002$) and vice versa in the post-pronoun window ($B = 0.45$; $SE = 0.17$; $t = 2.7$; $p = .009$). The group contrasts of interest did not differ significantly in the two time windows (pronoun window: Turkish-Dutch vs. others: $B = -0.26$; $SE = 0.32$; $t = -0.8$; $p = .429$; German-Dutch vs. monolinguals: $B = -0.09$; $SE = 0.37$; $t = -0.3$; $p = .800$; post-pronoun window: Turkish-Dutch vs. others: $B = 0.00$; $SE = 0.32$; $t = 0.0$; $p = .989$; German-Dutch vs. monolinguals: $B = 0.07$; $SE = 0.36$; $t = 0.2$; $p = .849$).

In sum, there were no significant effects of cross-linguistic influence: the Turkish-Dutch group did not behave differently from the other two groups. Furthermore, there was no evidence for a general bilingualism effect. Whilst the

bilingual groups differed from the monolingual groups in the local condition, they also differed from each other.

Effects of relative proficiency were (marginally) significant in the local (X^2 = 3.5; Δdf = 1; p = .060), disjoint (X^2 = 6.8; Δdf = 1; p = .009) and optional condition (X^2 = 5.1; Δdf = 1; p = .023). Turkish-Dutch children were more likely to look at the local referent than the disjoint referent with better relative proficiency in Turkish (local: B = 0.02; SE = 0.010; t = 1.9; p = .079; disjoint: B = 0.31; SE = 0.115; t = 2.7; p = .016; optional: B = 0.03; SE = 0.013; t = 2.3; p = .035). The interaction with time window was significant in the local condition (X^2 = 33.7; Δdf = 1; p <.001). Relative proficiency was significantly related to children's fixations in the pronoun window (B = 0.03; SE = 0.010; t = 3.3; p = .005), but not in the post-pronoun window (B = 0.01; SE = 0.010; t = -1.1; p = .274). Interactions were not significant in the disjoint (X^2 = 1.6; Δdf = 1; p = .205) and optional condition (X^2 = 1.1; Δdf = 1; p = .284).

3.2. Offline pronoun interpretation

Figure 3 shows the percentage of children's offline local referent choices. There was a significant effect of *condition* (X^2 = 909.5; Δdf = 2; p < .001), a non-significant effect of *group* (X^2 = 2.8; Δdf = 2; p = .250) and a significant interaction (X^2 = 22.0; Δdf = 4; p < .001). Children were less likely to choose the local referent in the disjoint than in the other conditions (B = -5.63; SE = 0.33; t = -16.8; p < .001) and in the optional than in the local condition (B = -1.71; SE = 0.20; t = 8.5; p < .001). None of the simple interactions of interest were significant.

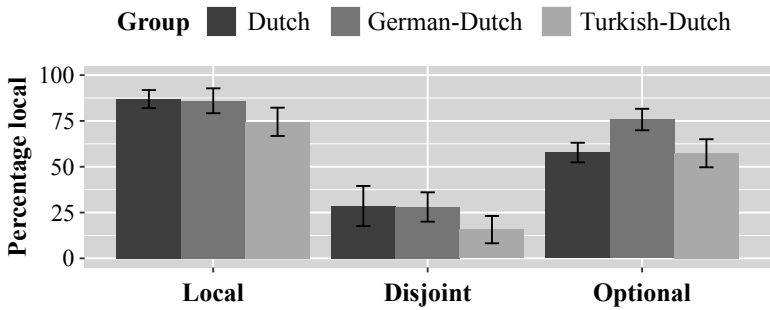


Figure 3. Average percentage offline local referent choices by *group* and *condition*. Error bars represent standard errors.

The effect of *relative proficiency* (X^2 = 3.1; Δdf = 1; p = .076) and its interaction with *condition* (X^2 = 7.7; Δdf = 2; p = .021) were (marginally) significant. The more Turkish-dominant children were, the more likely they were to choose the local referent (B = -0.05; SE = 0.029; t = -1.8; p = .066), which was significant in the disjoint condition (B = -0.09; SE = 0.029; t = -3.0; p = .003). However, on closer inspection the interaction was carried by two children with a high relative proficiency score who almost always chose the local referent.

Without them, the effect of *relative proficiency* stayed marginally significant (X^2 = 3.4; Δdf = 1; p = .064), but the interaction was not (X^2 = 3.7; Δdf = 2; p = .154).

4. Discussion

Before we turn to the discussion of the findings in relation to our hypotheses, we first briefly focus on the general patterns found in children's fixations during Dutch pronoun processing. Unexpectedly, children showed an initial online preference for the disjoint over the local referent, irrespective of group. Previous eye-tracking studies with monolingual children and L2 learners either showed no initial preference (e.g., Arnold et al., 2007; Cunnings et al., 2017; Song & Fisher, 2005) or an early preference for the topic antecedent (e.g., Contemori & Dussias, 2020) in non-null subject languages. Consequently, the task faced by children in our experiment was to suppress their initial disjoint fixations in the local and optional conditions in favour of the local referent. Our online and offline results showed that overall, children were successful at this: (i) they fixated significantly more on the local referent after having heard the pronoun in the local and optional condition; and (ii) they chose the local referent significantly more often in the local and optional conditions than in the disjoint condition. Hence, children's behaviour showed that they were able to make use of gender and discourse information in their online and offline pronoun resolution.

4.1. Group comparisons

We hypothesized that Turkish-Dutch children's online and offline interpretations of Dutch overt pronouns would be influenced by their Turkish pronoun preferences. Such cross-linguistic influence should be reflected by Turkish-Dutch children looking more at and choosing the non-topic disjoint referent more often when listening to Dutch pronouns compared to Dutch monolingual and German-Dutch bilingual children. These expectations were not borne out, neither online nor offline. The absence of predicted significant group differences contrasts with findings of cross-linguistic influence in L2 learners' online and offline pronoun interpretations from a null subject into a non-null subject language (e.g., Roberts et al., 2008; Schimke et al., 2018). Our results are in line with offline studies with children and online studies with adult L2 learners that did not observe cross-linguistic influence from a null subject into a non-null subject language (e.g., Argyri & Sorace, 2007; Cunnings et al., 2017; Sorace et al., 2009), in particular, from Turkish into Dutch (Roberts et al., 2008). In contrast to these latter L2 studies, however we did not find a general bilingualism effect with bilinguals showing slower processing irrespective of the language combination.

4.2. Language dominance

Concerning language dominance, we hypothesized that cross-linguistic influence would become stronger the more Turkish-dominant children were.

Increasing dominance in Turkish was predicted to be positively related to children's fixations on and choices of the disjoint referent. In line with our prediction, language dominance significantly modulated children's fixations and marginally significantly modulated children's offline choices. The direction of the relationship between dominance and fixations and offline choices was negative, however. In contrast to our prediction, children looked less at and chose the disjoint referent less with increasing Turkish-dominance.

How can we explain the unexpected effect of language dominance? We consider two explanations. The first is in terms of co-activation and inhibition. On such account, processing overt pronouns in Dutch activates both Dutch and Turkish pronoun interpretation preferences. Because Turkish and Dutch have conflicting preferences due to their (non-)null subject language status (e.g., Ariel, 2014; Cardinaletti & Starke, 1999), children might try to inhibit the Turkish non-topic preference (also see Hopp, 2017 for a similar proposal for word order overlap between an L1 and L2). If similar morphosyntactic properties in bilingual children's languages are shared (e.g., Serratrice, 2016), inhibiting the Turkish preferred strategy should also affect Dutch sentence processing: the non-topic interpretation becomes less available in Dutch as well. Consequently, Turkish-Dutch children looked less at the disjoint – non-topic – referent. Crucially, co-activation of this preference in Turkish only occurred, or was strong enough to require inhibition, when children's Turkish was sufficiently strong, explaining the language dominance effect. Only when children were relatively balanced in their languages as opposed to Dutch-dominant Turkish co-activation became strong enough to influence children's online pronoun choices in Dutch.

Support for language co-activation in bilingual children comes from various sources: indirectly from studies showing cross-linguistic influence at the level of morphosyntax (e.g., Serratrice, 2007); showing lexical co-activation (e.g.,Von Holzen & Mani, 2012); showing between-language priming (e.g., Vasilyeva et al., 2010); and showing structural co-activation and inhibition effects with word order overlap (van Dijk et al, accepted). The present study thus adds to these findings, offering support for the connectedness of bilingual children's languages.

The second explanation for our findings can also be formulated in terms of co-activation. Under this proposal, the presence of opposite strategies to interpret pronouns in Turkish and Dutch might have refrained children from directly committing to a certain sentence structure. Instead, they might have waited until they had accumulated sufficient information, for example about the gender properties of the pronoun, before making an – unconscious – choice for a referent. Indeed, the more balanced bilinguals in our study did not show a clear initial preference for a pronoun antecedent.

To disentangle explanations of possible cross-linguistic influence and language dominance effects in pronoun processing, future studies should take into account children's online and offline behaviour in their null subject language as well. If our first explanation is correct, children who are more Turkish-dominant should also have a stronger preference for a non-topic interpretation in Turkish compared to Dutch-dominant children. If our second explanation is correct, we should see similar online patterns in both balanced bilingual children's languages.

4.3. Online vs. offline

We also hypothesized that cross-linguistic influence offline should be a weaker reflection of cross-linguistic influence online. This prediction was borne out. Whilst there was a similar trend for language dominance online and offline, it failed to reach significance offline. This finding follows a co-activation account of cross-linguistic influence (e.g., van Dijk et al., accepted). During processing, pronoun preferences from both bilingual children's languages become activated and, in turn, preferences from the language not in use are inhibited. As our eye-tracking data showed, such effects unfold rapidly and were most pronounced in the pronoun time window (<740ms). It is possible that by the time children heard the offline comprehension question (750ms after the offset of a story) co-activation of the Turkish preference was already resolved. Furthermore, offline comprehension tasks tap into conscious processes and involves meta-linguistic awareness more than online tasks (e.g., Marinis, 2010). Consequently, a child's offline response might not always reflect their online behaviour.

Our account explains why effects of cross-linguistic influence were not significant in previous offline studies (e.g., Nicoladis, 2006). However, the absence of significant offline effects in this and previous studies could also be the result of insufficient statistical power due to a small sample size (van Dijk et al., 2021). More offline data is necessary to rule out such an explanation.

4.4. Conclusion

The present study was, to the best of our knowledge, the first to investigate cross-linguistic influence in online pronoun resolution in bilingual children. We found evidence for cross-linguistic influence from Turkish into Dutch. The more Turkish-dominant children were the less they looked at non-topic antecedents when hearing Dutch pronouns. A similar, although non-significant trend was observed offline. We explained our results in terms of co-activation and inhibition (e.g., Hopp, 2017; van Dijk, et al., accepted). This account correctly predicts stronger effects of cross-linguistic influence online than offline. Crucially, our study shows that online tasks are essential to better understand subtle effects of cross-linguistic influence in order to develop a comprehensive theory of cross-linguistic influence in bilinguals.

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