

## **The interaction between pauses and F0 in anaphor production in Mandarin strictly parallel structures**

Luying Hou, Bert Le Bruyn, René Kager

Utrecht Institute of Linguistics OTS, Utrecht University

*L.Hou@uu.nl, B.S.W.LeBruyn@uu.nl, R.W.G.Kager@uu.nl*

It has been observed that accent on pronouns can switch their interpretations in coordinated sentences with syntactically parallel structures like ‘John hit Bill and then George hit him [1]. Evidence on anaphora resolution shows that listeners employ a parallel referent assignment strategy: an unaccented pronoun co-refers with a prior constituent at the same grammatical position while an accented pronoun changes this preference to the competitor [2].

Most studies only focus on accentuation of pronouns themselves – here defined as local prosody [3]. As a discourse phenomenon, however, anaphoric reference is highly related to discourse structure that can also be encoded and decoded by global prosodic parameters of an utterance such as pause [3]. While studies on perception have demonstrated a close relevance between accented pronouns and the global prosody of the embedding discourse [4, 5], accented anaphors have received less attention from the production perspective under a global prosodic view. Noting that previous studies were based on either corpus materials or non-strictly parallel structures (with different verbs or adjuncts) in pitch-accent languages, this study investigates the interplay between anaphors’ F0 and pauses strictly parallel structures in a tone language – Mandarin. Both third person pronouns and proper names of high tone are under investigation, and the ambiguity of pronouns is controlled. Table 1 illustrates the manipulated factors: *Syntactic Position (SP)* and *Referential Status (RS)*.

Utterances from 36 speakers were elicited using ZEP software via a cooperative story-telling-and-comprehension game. Table 2 displays examples with the extracted prosodic information: 1) mean F0 and 10 equidistant F0 points of the concerned anaphors 2) duration of pauses at 5 positions. According to results on the interaction of tone and focus in Mandarin, F0 is raised for high tone at varied focal positions [6]. Hence higher F0 is expected for *Sh* and *Sw* based on observations on the reference-switching function of accented pronouns in English [1, 2]. Besides local F0, it is also anticipated that speakers may use pauses at crucial positions (before or after the anaphor or conjunction) to encode RS, in view of previous findings that pause duration influences pronoun resolution in English [7], and that pause duration is significantly correlated with specific boundary status in Mandarin discourse [8].

Statistical analysis using a generalized linear mixed model (GLMM) shows that: 1) No pauses exhibit significant differences except that pause 5 is significantly longer for *Sh* than *Sw* and *Un* ( $p < 0.01$ ) for subject anaphors. Figure 1 shows an overall higher occurrence of pause 5 in subject condition while the occurrence is consistent within each syntactic position. The mean duration of pause 5 is illustrated in Figure 2. 2) Subject *Sh* and *Sw* anaphors have significantly higher F0 than *Un* ( $p < 0.01$ ) and there is no significant difference between *Sh* and *Sw*, indicating that speakers use both F0 and a following pause to signal *Sh* but only use F0 to signal *Sw* for subject anaphors. 3) Object *Sh* and *Sw* anaphors have significantly higher F0 than *Un* ( $p = 0.000$ ) and F0 for *Sw* is significantly higher than *Sh* ( $p < 0.05$ ), showing that only local prosody is used to signal SR for object anaphors. 4) For *Sw*, F0 is significantly higher than *Un* at both syntactic positions but only significantly higher than *Sh* at object position, which indicates that speakers use the local prosody of both anaphors to encode the

switched relation but rely more on the second anaphor. Figure 3 displays the mean F0 contours of the anaphors. These results reveal that speakers use both local and global prosodic marking as combined strategies in anaphor production, which is sensitive to both SR and SP.

Table1. An Example with prosodic information of F0 and pause extracted

Factor	Description	Values	abbr.	Explanation
Syntactic Position	syntactic position of the anaphor	Subject	S	the anaphor is subject
		Object	O	the anaphor is object
Referential Status	relative syntactic position of an anaphor and its antecedent	Shifted	Sh	the anaphor and its antecedent are at opposite positions
		Switched	Sw	the 2 anaphors and their antecedents are at opposite positions
		Unchanged	Un	the anaphor and its antecedent are at the same position

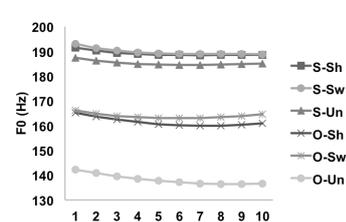
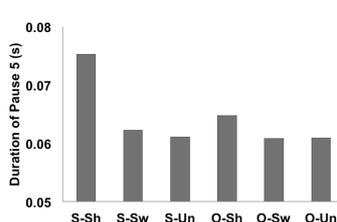
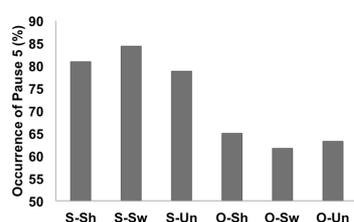
Table2. Examples with prosodic information of F0 and pauses extracted (English translation)

Everyone was playing basketball. First [Pause 1] Xiao Dang [Pause 2] pushed Xiao Gang, [Pause 3] and then [Pause 4]		
Subject pronoun/name	Shifted	<b>he/Xiao Gang</b> (F0) [Pause 5] pushed Xiao Fang
	Switched	<b>he/Xiao Gang</b> (F0) [Pause 5] pushed Xiao Dang.
	Unchanged	<b>he/Xiao Gang</b> (F0) [Pause 5] pushed Xiao Fang
Object pronoun/name	Shifted	Xiao Fang [Pause 5] pushed <b>him/Xiao Dang</b> (F0).
	Switched	Xiao Gang [Pause 5] pushed <b>him/Xiao Dang</b> (F0).
	Unchanged	Xiao Fang [Pause 5] pushed <b>him/Xiao Gang</b> (F0).

Figure 1. Occurrence of Pause 5

Figure 2. Mean value of Pause 5

Figure 3. Mean F0 contours



## References

- [1] Akmajian, A., & Jackendoff, R. (1970). Coreferentiality and stress. *Linguistic Inquiry*, 1(1), 124-126.
- [2] Theune, M. (1999). Parallelism, coherence, and contrastive accent. *Proceedings of Sixth European Conference on Speech Communication and Technology* (pp. 555-558).
- [3] Jasinskaja, E., Kölsch, U., & Mayer, J. (2005). Global prosodic parameters and anaphora resolution. *In Proceedings of the International Symposium on Discourse and Prosody as a Complex Interface, Aix-en-Provence, France.*
- [4] Dogil, G., Kuhn, J., Mayer, J., Möhler, G., & Rapp, S. (1997). Prosody and discourse structure: Issues and experiments. In A. Botinis (ed.), *Intonation: Theory, Models and Applications*. ISCA Archive, [http://www.isca-speech.org/archive\\_open/int\\_97](http://www.isca-speech.org/archive_open/int_97).
- [5] Sánchez, L. R., & Boix, J. L. (2012). Prosodic correlates of pronoun disambiguation in Spanish. *Estudios de fonética experimental*, (21), 6.
- [6] Xu, Y. (1999). Effects of tone and focus on the formation and alignment of F0 contours. *Journal of phonetics*, 27(1), 55-105.
- [7] Mayer, J., Jasinskaja, E., & Kölsch, U. (2006). Pitch range and pause duration as markers of discourse hierarchy: perception experiments. In *INTERSPEECH*.
- [8] Yang, L. C. (2004). Duration and pauses as cues to discourse boundaries in speech. In *Speech Prosody*.