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Mouth/Hand Interaction in the Production of Prosodic Focus

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INTRODUCTION

Many studies have shown that manual gestures are naturally produced in spoken communication (McNeill, 1992; Kendon, 1997). The links between hand gestures and speech were mainly analyzed qualitatively and most studies showed that brachio-manual gestures and speech are tightly bound. In particular, it appears that gestures are linked to prosody: intonation (McClave, 1998), fundamental frequency (Pietrosemoli *et al.*, 2001) and higher formants (F2, F3) (Krahmer & Swerts, 2007). Some studies have tried to shed light on the temporal organization of speech and manual gestures using motion capture. Levelt and colleagues (Levelt, 1985) studied the coordination of speech and pointing gestures and found that speech seems to adapt its timeline to that of the deictic gesture. Rochet-Capellan and colleagues (in press) find that the apex of the pointing gesture usually occurs during the articulation of the stressed syllable (among two). Another interesting study is that conducted by Krahmer and Swerts (2007) which studied prosody related beat gestures of the head, eyebrow and hand (an up-down movement of the fist/hand often performed in relationship with prosodic emphasis). They find that production of a beat gesture increases muscular activity used for articulation.

The aim of this study is to characterize the interaction between speech and manual gestures in the production of prosodic focus. Prosodic focus consists in putting forward a word or a group of words within an utterance or discourse. It can actually be considered as a form of pointing towards the part of the utterance bearing the important information. In that sense, it is naturally close to manual pointing.

We would like to address several key questions: (1) Is coordination between speech and hand related to the gesture produced (communicative vs. non communicative)? (2) Is coordination between speech and hand dependent on the type of communicative gesture (deictic vs. non deictic)? (3) For the pointing gesture, is the coordination dependent on the correspondence between what speech focuses and what the hand shows?

METHODOLOGY

In this study, we investigated three types of gestures: index finger pointing (deictic communicative gesture), beat gesture (nondeictic communicative gesture) and a control gesture (non-deictic non communicative gesture) consisting in pressing a button. Note that index finger pointing can be performed on its own without any speech. Two experiments were designed.

The first experiment aimed at addressing questions (1) and (2). In this experiment, participants performed a correction task eliciting the production of prosodic focus. Two conditions were recorded: speech alone and speech + gesture (for each gesture type).

The second experiment aimed at addressing mainly question (3) although it could also provide information for questions (1) and (2). The task was the same except that the targets of pointing gesture and speech focus were not exactly the same (ex: pointing at a red balloon and focusing "red").

The technical setup used for both experiments was the same. The participants sat in a chair facing a translucent screen on which the pointing targets appeared (useful for the pointing gesture type). The movements of their mouth (jaw and lips) and right hand were recorded using a NDI Optotrak IRED tracking device (mouth: 4 markers; hand: 3 markers). Auditory and visual stimulation were presented using Neurobehavioral Systems' Presentation software. The vocal productions of the speakers were recorded using a microphone. The analyses were conducted using Praat and Matlab.

Twenty adults (eight women, twelve men; age-range, 22-65 years) participated in both experiments. All were right-handed and native French speakers. The order in which the participants went through both experiments was varied across participants.

PRELIMINARY RESULTS

Up to now, only part of the data was processed and analyzed (10 speakers). The results presented here are thus preliminary but some interesting observations emerge.

It appears that the production of a manual gesture does not seem to affect the timeline of speech production (timing of articulatory gestures within the utterance). For the pointing gesture, it appears that the events with which the alignment is the tightest are articulatory lip targets corresponding to vocalic gestures.

The type of communicative gesture (deictic vs. non deictic, cf. question (2)) seems to have an effect on the timing of the gesture relative to speech. Indeed, beat gestures seem to last longer and their alignment with speech is clearly different than that observed for pointing gestures.

As for question (3), there is a difference in the timing of the pointing gesture relative to prosodic focus between the two experiments: when prosodic focus is on the subject *i.e.* beginning of the utterance (resp. on the object, *i.e.* end of the utterance), the gestures are produced later (resp. earlier) in the second experiment than in the first one.

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