DISTANCE ENCODING IN KINEMATIC PROPERTIES OF MANUAL POINTING

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Deixis is a communicative process about showing and sharing information. Its specificity is that it involves both the vocal and the gestural modalities, being then a perfect case of speech/gesture interaction. The particular relationship between speech and gesture has been demonstrated many a time, from phylogenetic [1, 2] to ontogenetic perspective [3, 4], not to mention neurophysiological data [5, 6]. Furthermore, experimental studies reveal that these two systems interact with a specific temporal synchronization [7].

The aim of this work is to experimentally study the spatial features of deictic pointing, especially the way it encodes distance information. The distance of a designated object is indeed a spatial feature that we believe can be encoded both through vocal and gestural modalities. In a previous study [8], we investigated the articulatory and acoustic correlates of distance in vocal pointing. Our first results showed that the distance of the target influenced both acoustical values (first formant) and articulatory gestures (lip opening). The present paper aims at characterizing the kinematic properties of distance encoding in manual pointing: does manual pointing also carry distance information and thus vary with the target distance? This hypothesis has been tested with the following experimental situation. Participants were seated in a soundproof room, in front of three light-emitting diodes (LEDs). LEDs were placed at 55cm (peri-personal space), 140cm (extra-personal close space), and 425cm (extra-personal far space). The two LEDs out of reach of the hand were aligned with respect to the subject's eyes, so that the angle of the arm can not be used to disambiguate which target was pointed at. Participants were required to name and simultaneously to point at the turned-on LED using an index finger pointing. We recorded index finger movements with the motion capture system Optotrak-3020, which allowed us to measure the duration (s) and amplitude (mm) of the pointing gesture, as well as its stroke speed (mm/s). A repeated-measures analysis of variance was conducted on 18 participants, with target distance as a fixed-factor. For each measurement, the median value was used for the statistical analysis, with a significance level fixed at $p<0.05$. The results show that target distance has a significant effect on the duration, amplitude, and stroke speed of the manual pointing. Participants perform longer ($F(2, 34)=34.9$, $p<0.05$), wider ($F(2, 34)=83.7$, $p<0.05$), and faster ($F(2, 34)=51.43$, $p<0.05$) manual pointings to designate a distant target (see Figures 1, 2 & 3). Post-hoc analyses on each measurement show significant differences for each distance in pairs.

Our results attest that, in a communicative situation, people convey spatial information about the referent position. To designate a distant referent, they use not only a reinforced vocal pointing (i.e. higher first formant values and larger lip opening values), but also a specific manual pointing. Considering these findings could improve the modelling of conversational agents able to communicate with humans in the most natural way.

Figures

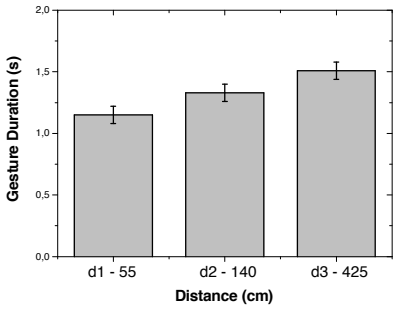

Fig.1 . Gesture duration (s) as a function of the target distance.

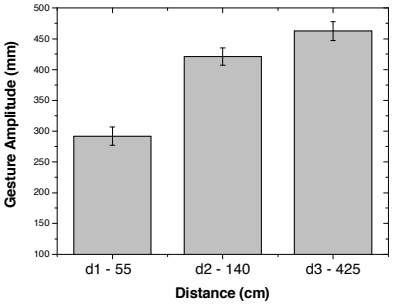

Fig.2 . Gesture amplitude (mm) as a function of the target distance.

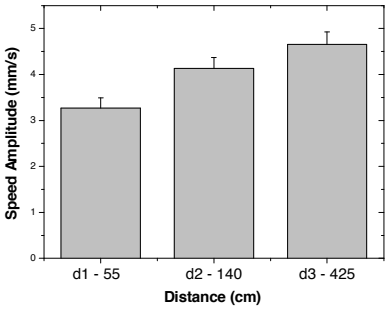

Fig.3 . Speed Amplitude (mm/s) as a function of the target distance.

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