

Hand movements that accompany verbal descriptions differ from those during gestural demonstrations

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Introduction: Gestures do not only convey information (McNeill, 1992) but also reflect the person's feelings or emotions (Feyereisen & de Lannoy, 1991). As the exact function of co-speech gestures is still under debate (Holler & Wilkin, 2011), we investigate in this study hand movement behavior regarding the functionality of the two hands either as co-speech gestures or gestural demonstrations without speech. Previous studies have shown differences between conditions with or without speech when investigating iconic hand movements (Lausberg & Kita, 2003, Goldin-Meadow et al., 1996). Contrasting gestural output between a speech and a silent condition showed that more hand movements are performed during silent conditions. Both studies focused on iconic hand movements not including the entire hand movement behavior. Thus, we explore in this study the functional purpose of hand movements including the complete manual repertoire.

Methods: Hand movement behavior of eleven healthy right-handed participants was videotaped for gestural analysis. Participants sat in front of a computer on which drawings of everyday life action scenes, e.g. a skipping girl, were presented. In the silent condition, subjects were asked to demonstrate with hand movements only, i.e., without speaking, the content of each drawing. In the speech condition, participants were asked to verbally describe the drawing. The subject's videotaped hand movements were evaluated by two independent blind raters with the Neuropsychological Hand Movement Coding NEUROGES-ELAN-System (Lausberg & Sloetjes, 2009). A modified Cohen's Kappa was calculated for all NEUROGES categories for interrater agreement according to Holle & Rein (forthcoming).

Results: Overall, the frequency of all hand movement units between the silent and verbal condition was not different. Hand movements showed differences regarding their kinesic *Structure, Focus, Formal Relation, and Function*. In the silent condition as compared to the speech condition, participants displayed significantly more *phasic* and *repetitive in space* units. In contrast, during the verbal condition, there was a significantly higher frequency of *irregular* movement units ($Condition*StructureFocus, F(5, 5) = 124.728, p < 0.001$). Furthermore, with regard to bimanual coordination, there was a higher frequency of *symmetrical* and *asymmetrical* hand movements during the silent condition. In the verbal condition, participants executed more *independent* hand movements ($Experiment*Formal Relation F(6, 4) = 45.439, p < 0.01$). With regard to the function of gestures, during the silent condition, significantly more *pantomime* gestures were executed. During the verbal condition, significantly more *emotional* hand movements such as *shrugs, rise* gestures and *opening shifts* and *subject-oriented* hand movements have been executed ($Experiment*Function, F(5, 6) = 6.065, p < 0.05$).

Discussion: In contrast to previous studies, the frequency of hand movements units during silent and verbal conditions, considering all occurring hand movements, did not differ. Different frequencies of hand movements were executed regarding their *Structure, Focus, Formal Relation, and Function*. As more information is transmitted by the hands during the silent than during the verbal condition (Lausberg et al., 2003, Cassell et al., 1998), more *phasic* and *repetitive in space* hand movements leading to high amounts of *pantomime* gestures are executed without speech. In contrast, during the verbal condition, hand movements served rather emotional and self-regulatory functions than for the transmission of information. This indicates different functions of hand movements between a silent and a verbal condition. It seems that when speech takes over to transmit the information, the hands do not decrease their motor activity but they adopt a different function, shifting towards self-regulation.

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