Cognitive Effort and Gesticulation

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It has been argued that producing hand gestures can sometimes aid a speaker's cognitive performance and facilitate learning (*i.e.* Lozano & Tversky, 2006; Cook *et al.*, 2008). This is a so-called for-speaker function of gesticulation. It has also been shown that addressees can benefit from speaker's gestures (*i.e.* Lozano &Tversky, 2006). And much evidence has been found that gestures are adapted to specific communicative contexts, such as whether the addressee can see the speaker (*i.e.* Bangerter and Chevalley, 2007) and whether or not the addressee already knows (part of) what the speaker is about to tell (Jacobs & Garnham, 2006).

In a previous study we too found evidence that some gestures are intended communicatively (Mol *et al.*, 2007). We found that while performing a narration task, hardly any gestures were produced towards an audiovisual speech recognition system, whereas many gestures were produced towards human addressees. This makes it unlikely that most gestures were performed solely for the benefit of the speaker, since in both cases the same task was performed, and verbal descriptions were similar. A somewhat surprising finding of this study however was that whether speaker and addressee could see each other only had a relatively small effect on gesticulation. How could it be that if most gestures were intended for the addressee (as shown by the difference between narrating to a human or non human addressee), those gestures were still produced to an addressee who could not see the speaker?

Our hypothesis is that the cognitive demands of the narration task may have been too high for speakers to simultaneously retell the story and adjust their gesture production to the specific communicative setting. Rather than gestures always being facilitative to cognition, producing communicative gestures may require speakers to put in considerable effort. Therefore, in the current study, we adjusted the narration task. Instead of watching an eight episode cartoon and retelling all episodes at once, we asked participants to view and retell one episode at a time. As in some conditions of the previous experiment, participants did so either face-to-face, or with a wooden screen in between speaker and addressee (a design taken from Alibali *et al.*, 2001). This renders a two by two, between subjects design, which is schematically depicted in Figure 1.

Our prediction was that with an easier narration task, gesticulation would be better adapted to the communicative context. Thus, with the easier task, we would expect more gestures in the face-to-face situation and fewer gestures in the condition with a screen in between speaker and addressee, compared to the preceding study, with the harder task. Note that a theory explaining gesticulation solely in terms of facilitating speakers' cognition or verbal language production would predict fewer gestures in both conditions of the new experiment, since the task is easier than in the previous study and would thus call for fewer facilitating gestures.

We found that this manipulation of the narration task, which lowers the demands on memory for the speaker, indeed enlarged the difference in gesticulation between the face-to-face condition and the condition in which speaker and addressee could not see each other. A main effect of visibility on the number of gestures per 100 words was found ($F(3, 35) = 28.98$ $p < .001$) as well as a significant interaction with the difficulty of the narration task ($F(3, 35) = 5.564$, $p < .05$), see Figure 2. With the easier task, verbal descriptions were much longer than with the harder task ($F(3,35) = 34.25$, $p < .001$). There was no significant effect of mutual visibility on the number of words used.

With the easier task, in the condition where speaker and addressee could not see each other, verbal descriptions were longer, yet not more gestures were produced. In the face-to-face condition, both longer verbal descriptions and more gestures per word were produced with the easier task. This again shows that the production of some gestures depends on whether or not speaker and addressee can see each other. Additionally, this indicates that speakers are well able to adjust their non-verbal communication to a specific communicative context, independent of their verbal language use. And more importantly, this supports our idea that the memory demands of the narration task and the

cognitive demands of producing communicatively intended gestures were in competition for cognitive resources. It shows that the production of communicatively intended gestures requires significant cognitive effort of the speaker, just as the production of communicatively intended verbal language does.

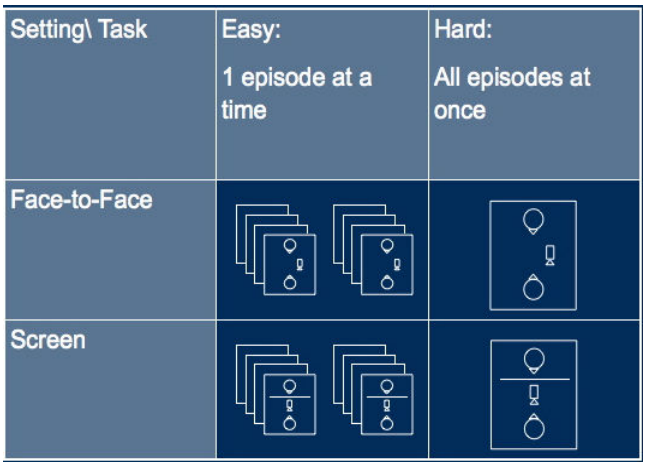

Figure 1 – *Design*

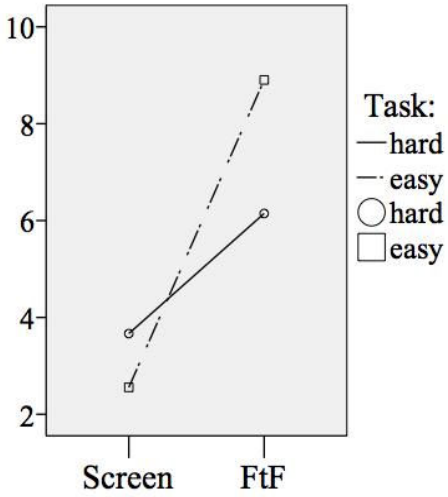

Figure 2 – *Mean Gesture Rate (number of gestures/ 100 words)*

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