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Thoughts on the table: Gesture as a tool for thinking in blind and visually impaired children

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Abstract

The theory of embodiment (Lakoff and Johnson 2003; Gibbs et al. 2004) explains the origin of meaning by postulating that thought is influenced by sensorimotor experience (Robbins and Aydede 2009). However, the relation between the body, mind and environment is not unidirectional. Not only do we derive information from the world, but we are also able to use it as an extension of the mind through epistemic actions, strategies that minimize the cognitive load by offloading it onto the environment (Kirsh and Maglio 1994). This paper investigates the potential of gesture as epistemic action. 12 blind and severely visually impaired children and young adults, as well as a control group of 7 young adults were interviewed for the purpose of the study. Participants were asked to explain a set of abstract and concrete concepts while their speech and gestures were recorded. If gesture indeed plays a role in reducing the mental load by externalizing thought, more gestures should be produced for concepts that are more difficult to describe (in this case: abstract, intangible concepts). Qualitative data analysis, as well as simple statistical analyses of gesture type, number and gesture per word rates show that abstract concepts do not generate more gestures, but do prompt blind and visually impaired speakers to use simulation gestures. These gestures constitute reenactments of situations associated with a given concept by the respondent. They are also thought to confirm the embodied cognition hypothesis (Hostetter and Alibali 2008). A number of examples demonstrates that abstract concepts in blind children are strongly grounded in their experience of real-world situations. Findings suggest that gesture is not merely a tool for communication, but a way of extending the capabilities of the mind.

Keywords: gesture; conceptual metaphor; abstract conceptualisation; concept formation.

1. Introduction

Although research investigating the role of gesture in language often focuses on the communicative function of the former, studies show that spontaneous ges-

ture facilitates thinking (Goldin-Meadow 2005), and provides such information about thought that may be inaccessible through language (Alibali and Goldin-Meadow 1993; Alibali et al. 1997). These findings suggest that gesture analysis need not focus solely on communication, and that an approach that goes beyond the strictly communicative function of gesticulation has significant potential for cognitive scientific research, most notably providing an alternative, non-linguistic source of data about categorisation and conceptualisation. In fact, a multitude of studies have demonstrated that gesture is not merely a tool for interaction, but rather acts as a facilitator in communication (Krauss et al. 1995, 1996), reasoning (Casasanto 2008), and learning (Alibali and Goldin-Meadow 1993; Alibali et al. 1997; Goldin-Meadow 2014). Spontaneous co-speech gesture and the co-occurring speech appear to be congruent in a manner which indicates that gesture and language are interdependent manifestations of thought. Such gestures have been shown to play a facilitative role in conceptualisation (Hostetter and Alibali 2008). Both observing and performing gestures appears to be involved in the learning process (Goldin-Meadow 2014).

The conceptual role of gesture can, perhaps, be most felicitously analysed in the performance of persons with an early or congenital severe visual deficit. Analysis of the gestural performance of blind children and young adults clearly shows that, just as for their sighted peers, gesture is an important step in their pre-linguistic development (Iverson et al. 1998). Furthermore, early and congenitally blind persons have been shown to use gesture in a similar manner and frequency as the sighted (Iverson and Goldin-Meadow 1997, 2001), even in situations when the interlocutor is known to be blind. This can be taken to mean that the functions of gesture do not differ significantly between the blind and sighted population. What can be considered different, however, is the manner in which gesture is acquired or learned. While it is nearly impossible to differentiate between gestures that have, and ones that have not been learned through observation in the sighted, early and congenitally blind and severely visually impaired persons – due to their limited exposure to visuogestural input – can be assumed to produce gesture that is largely spontaneous, in the sense that the shape of the movement remains relatively uninfluenced by factors external to the gesturer.

A variety of hand and body movements can be considered gestures, and a plethora of authors sought to describe and define these different gesture types (e.g. Kendon 2004; McNeill 1992). In this paper, we limit our discussion to two types of gesture: representational gestures and blindisms. Representational gestures are movements that refer to the content of an utterance by pointing to ob-

jects in physical space (deictic gestures), directly refer to an object with the motion or shape of the hands (iconic gestures), or indirectly represent an abstract idea by using a concrete referent or a spatial location (metaphoric gestures). Here, these types have been conflated into a single category, namely representational gesture. Nevertheless, it is worth noting that views on where distinctions should be drawn in gesture typologies vary. Blindisms are a particular type of adaptor gesture typical for the early and congenitally blind population; a repetitive or unusual behaviour, "including a wide variety of activities, ranging from minor head and hand motions (e.g. head turning, hand rubbing, unusual hand postures) through varied rhythmic postural activities (body rocking, rhythmic swaying) to highly complex, ritualistic patterns" (Smith et al. 1969). The reasons for including blindisms in the analysis of the gesture performance of the blind and severely visually impaired group while omitting adaptor gestures from the overall gesture count of the sighted control group follow extensive consultations and are twofold. First, there is no reason to believe that adaptors were synchronic, or interdependent with speech in healthy participants, while the small pool of research on the conceptual correlates of blindisms suggests that their occurrence is related to speech fluency and cognitive effort in the blind population (Blass et al. 1974). Second, the visual nature of adaptor gestures and blindisms recorded in this study differed significantly, with the latter displaying a far greater variability in shape, type and frequency of use. Both of these arguments were taken to indicate that, while adaptor gestures in healthy participants may be discarded as relatively non-informative, it is impossible to do so with regard to blindisms as clear evidence of their broader function would have to be willfully ignored.

In this paper we seek to identify whether gestures used while speaking and performing a relatively difficult cognitive task function as epistemic actions. In particular, we ask which gestures produced by early and congenitally blind and severely visually impaired youth appear to function as epistemic actions, in the sense that they externalise meaning through physical action and serve to reduce the cognitive load. Our main goal is to analyse how gestural strategies are employed in a complex conceptual task. Although the population chosen for this particular study imposes a number of methodological and analytical constraints delineated further in this paper, the authors believe that an analysis of the gestural performance of the pertinent group makes a valid contribution to the field of gesture studies, as it focuses almost exclusively on gestures that have not been socially conditioned and can, therefore, be taken to be indicative of the participants' natural inclinations.

2. Epistemic actions

Physical actions have long been considered to primarily serve one purpose: to influence the external world. Kirsh and Maglio (1994) demonstrated, however, that physical actions can also become tools for thinking. Some "cognitive and perceptual problems are more quickly, easily, and reliably solved by performing actions in the world than by performing computational actions in the head alone" (Kirsh and Maglio 1994). Physical movements that do not bring the agent closer to achieving a physical goal but serve to improve their cognitive performance on a task are epistemic actions. For instance, participants who were playing a game of tetris have been shown to rotate blocks on a computer screen not only with the express purpose of fitting them into the block arrangement (which is the goal of the game), but seemingly also to simplify this cognitive task. Thus, the researchers distinguished between pragmatic actions, performed to bring one physically closer to a goal, and epistemic actions, performed to reveal information that is hidden or difficult to compute mentally.

Naturally, a similar, function-based distinction can be drawn in gesture analysis. Indeed, gesture researchers have been applying a number of function-based gesture typologies; for instance that of communicative and cognitive (Goldin-Meadow 2005) or inter- and intrapersonal gesture (Krauss et al. 1996). Such typologies divide gestures into non-mutually exclusive categories of those that serve an explicitly communicative function, and those that have been shown to aid understanding, learning (see e.g. Goldin-Meadow 2014), and speaking (e.g. Kita 2000). The dual role of gesture has been well documented (e.g. Kendon 1994). However, the authors feel that the current gesture definition and typology, which draws a line between actions and gestures, may be at times unnecessarily restrictive. The term "gesture" implies the absence of a physical referent as gestures "manifest imagery" (McNeill, 1992), and "represent action" (Goldin-Meadow and Beilock 2010), while actions are movements that manipulate objects (Cartmill et al. 2012). However, this distinction is less clear at the interface between these categories. As Kirsh and Maglio show, epistemic actions are not meant to influence reality, but rather have the potential to improve the subject's performance on a given task. Therefore, it would be interesting to see whether it is possible for gestures to perform the role of epistemic actions, and which gestures have the potential to be classified in this manner. In a way, showing that it is possible for gestures to function as epistemic actions would show that gestures and actions are overlapping categories.

Although the GAS framework of Hostetter and Alibali (2008) is not function-driven, the idea that gestures can constitute epistemic actions, or become a tool for thinking that externalises meaning through reenaction does appear to fit in with their proposal that gestures are, in fact, embodied simulations resulting from a direct extension of mentally simulated action and perception. Therefore, the idea whether gestures can be epistemic actions is worth exploring. Nevertheless, identifying the function of a particular gestural movement is still a difficult task because the gestural repertoire of healthy individuals can be assumed to be influenced by the environment, particularly by watching other people use gesture. For this reason, the present study focused on the gestural performance whose visual exposure to gesture was severely limited.

3. Study

The authors sought to investigate the potential of gesture as epistemic action, in particular its role in the gestural repertoire of blind and severely visually impaired children and young adults. In order to do so, a series of research questions were asked. First, whether the gestural performance of blind and sighted participants was comparable in both conditions, or whether crucial differences precluded generalisation of the results obtained from the blind group onto the general population. Second, whether gestures could be epistemic actions and, if so, which gestural strategies appeared to function as such. With regard to the first question, previous research suggested that the number of produced gestures and words should not differ significantly between the populations (Iverson and Goldin-Meadow 1997, 2001). Although this prediction appears to have been confirmed, the individual variability of results between the blind participants precluded any further meaningful statistical comparison between the groups. As for identifying whether gestures are epistemic actions, serving to reduce the cognitive load through actions that are not meant to influence the physical world but rather aid reasoning, it was assumed that those gestures that occur (not necessarily exclusively) in the descriptions of abstract concepts can be classified as potentially epistemic. This is because gestures depicting concrete concepts can be interpreted as representative of their embodied representations, rather than indicative of any attempt to reduce the cognitive load. Second, the authors decided to focus more on those strategies that occurred in the performance of the blind and severely visually impaired group, as the development of their gestural repertoire is believed to be relatively uninfluenced by external visual cues.

3.1. Method

The study was conducted in three stages. During the first stage, the researchers focused on observing natural interactions between congenitally blind, early blind and severely visually impaired children and young adults in a boarding school for blind students. This stage consisted of class observation and supervised teaching, as well as the organisation of extracurricular activities for the students. This stage of research answered ethical as well as practical concerns. First, studies that involve disabled or underprivileged participants need to be conducted with their best interest in mind. It would be unethical to ask children and young adults from a vulnerable population to participate in a study that analysed their verbal and non-verbal behaviour but did not benefit them, or their community. Therefore, the authors decided to devote six months of their project to voluntary work, aiming to support the small disabled community with whom they wanted to work. Second, time spent volunteering with the community allowed the researchers to observe the communication behaviour of blind and visually impaired children and young adults, and establish relations with potential participants in a relatively stress-free environment. In this way, the researchers hoped to reduce the impact of their presence on the psychological validity of the study. The first stage also served as a source of data for adjusting the experimental design and stimuli. After the observation period the study moved to its experimental, and, following that, analytical stages. The experimental stage of the project was conducted on the premises of the boarding school for the blind and visually impaired in which the observations took place. Choosing an environment both familiar and friendly to the participants was vital because the participants had to feel safe, confident, and at ease. Well-known surroundings empowered the blind and visually impaired students to use gesture, which otherwise might have been inhibited by such considerations as fear of hitting or hurting oneself or others in unfamiliar circumstances. The control group was also recorded on their school premises. The third phase of the project consisted of data annotation and analysis. Some of the conclusions drawn from the experimental part of the project are presented in the subsequent sections.

3.2. Participants

Twelve blind and severely visually impaired children and young adults participated in the study. There were two age groups: six children (age range: 7 to 11

years old) and six young adults (age range: from 16 to 19 years). Altogether, there were eight female and four male respondents. All participants belonging to these two groups were congenitally functionally blind or lost sight at an early age. They were either fully or functionally blind; most had some residual vision – light or movement perception. Importantly, none of these participants had a record of cognitive impairments. A control group of seven sighted age- and gender-matched young adults were recorded at a later stage of the project.

3.3. Stimuli

The stimuli used in the experimental part of the project were audio recordings of Polish words that denoted either abstract or concrete concepts. The lexical items were pre-tested for understandability, frequency and tangibility in the course of a previous study (Jelec and Jaworska 2011). There were 21 abstract and 21 concrete words used in two experimental conditions: dialogue and monologue. In both conditions the task was to explain the presented concept. In monologue the participants' task was to elaborate on a provided concept, in dialogue the computer asked the participant a number of questions regarding the concept. A computer programme randomly chose 10 words for each experimental condition and played them for the participant to explain. The list of words used in the study can be found in Appendix A to this paper.

3.4. Procedure

The experimental part of the study was conducted in two stages, both of which employed a free speech and gesture elicitation paradigm. In both parts, the participants heard ten randomly chosen abstract and concrete concepts. In the first stage, their task was to explain the meaning of each concept verbally and by means of gesticulation. In the second stage, the task remained the same but the computer provided a number of additional cues, such as "Show me what it is", "Show me what it is like", "Show me where I can find it" and "Show me what you think of it". The cover story presented to the participants was that the aim of the study is to teach the computer the meaning of unfamiliar words.

The motivation behind using computer interaction rather than conducting directed interviews with the participants was twofold. First, it allowed the re

searchers to control the experimental procedure. As two out of the three groups of participants involved in this study (blind children and young adults) were expected to exhibit great individual variability (Majewski 1983), attempts were made to control other conditions and variables in the experiment. Second, following extensive observations and preliminary interviews with potential participants, the authors decided that interaction with a computer is preferable to researcher directed interviews. Because the experiment was conducted in a school setting, the students tended to automatically fall into familiar student-teacher interaction patterns with the researchers. Their answers would be tailored to the expectations of who they perceived to be the authority figure in the room, and their gestural repertoire would be sparse. Introducing the computer as an interlocutor, and one that was in the position of a student who had to be "taught" certain concepts, allowed for a role reversal, empowering the students to use language and gesture more freely than would otherwise be allowed in a classroom environment. Most students enthusiastically assumed the role of the teacher; this methodological choice appeared to have the best effect on the youngest participants.

The participants' speech and gesture were recorded by two cameras: the iSight camera built in the laptop used in the experiment, and a digital camera placed on a tripod at a distance from the participant. No visual stimuli were used in the experiment so as not to introduce the varying visual sensitivity of the subject and control groups, as well as different levels of visual acuity of the functionally blind participants as variables in the study.

At the beginning of the experiment, each participant was seated in front of a computer screen, with their palms resting on the surface of a table in front of them. Before the instructions were given, participants were informed that the study was recorded. Care was taken to familiarise the participants with the nature of the study in order to get their informed consent.

4. Annotation

The gesture analysis performed for the purpose of the study is based on the methodology proposed by the McNeill lab (McNeill 1992, 2005). Identification and annotation of gesture was preceded by full orthographic transcription of participants' responses done in ELAN, a professional software for multimodal research (Brugman and Russel 2004; Sloetjes and Wittenburg 2008; Wittenburg

et al. 2006). Each video was analysed in terms of gesture occurrence and its synchronicity with speech. The annotation was performed by three researchers, trained on the criteria for annotation whose unanimity concerning gesture identification was randomly checked. The annotation of most videos was performed by two independent researchers. In the few cases where inconsistencies occurred, there was a third independent rater who provided feedback.

For annotation purposes the authors adopted Kendon's temporal gesture anatomy (Kendon 1972), dividing gestures into units and phrases. Participants' full response to a question was considered to be a gesture unit, as responses reliably began and ended with the participant's hands in a resting position on a table. A gesture phrase was defined as a movement that began in the preparation phase and ended with the retraction phase, unless it ended at the beginning of the preparation stage for another gesture, nested or otherwise. In case of blind and severely visually impaired participants, blindisms were included in the annotation for reasons delineated in section 1 of this paper. The cognitive function of these specific adaptor gestures is as yet insufficiently explored to tell whether they are semantically correlated with speech. However, there is evidence pointing to blindisms having a broader cognitive function than is generally assumed by educators (Blass et al. 1974). Furthermore, blindisms accounted for a significant proportion of all gestures in the gestural repertoire of blind and severely visually impaired participants, particularly in the youngest age group.

5. Results

The analysis aimed to answer a series of questions. First, the authors conducted a statistical analysis to find out whether the gestural performance of blind and sighted participants was comparable in both conditions, or whether crucial differences precluded generalisation of the results obtained from the blind group onto the general population. This took the form of exploratory statistical analysis of means, comparing the number of gestures produced per gesture unit by each of the groups for abstract and concrete concepts. Before any further calculations, data distribution was checked; following this, the responses obtained from one participant had to be excluded from further analysis as an outlier. Figure 1 demonstrates that although the overall number of gestures and words produced by the two young adult groups (blind and seeing) was comparable, the youngest age group was much less expressive in speech and gesture. However,

as demonstrated in both Figure 1 and 2, there was considerable individual variation between the participants, prompting the researchers to interpret all further statistical results with caution.

5.1. Quantitative analysis of gesture in abstract and concrete concepts

While it was assumed that age-matched blind and control groups would gesture at a similar rate, an exploratory analysis has shown no statistically significant difference in case of abstract concepts, and a small effect in concrete concepts where the blind young adult group gestured more. Analysis of means showed a difference in performance of the two young adult groups for both concept types: in both conditions, blind participants performed more gestures per response. Their mean gesture rate for abstract concepts was 4.96 (SD = 3.94), while the mean of the control group was 4.212 (SD = 4.34). This difference was greater for concrete concepts. A statistical analysis using a T-test for Significance for Two Unknown Means and Unknown Standard Deviations (assuming normal distribution) showed that the difference for concrete concepts reached statistical significance: blind participants performed more gestures (M = 5.14, SD = 3.35), than seeing controls (M = 3.62, SD= 3.70, $t(65) = 2.34$, $p > 0.05$). This effect may possibly stem from the inclusion of blindisms in the analysis of blind participants' gestures, although it would be interesting to see why it did not spread across both concept types. Another possibility is that blind persons' knowledge of concrete concepts is significantly more embodied (in the sense that it is based on tactile rather than visual experiences), which has an effect on gesture rates for concrete, but not abstract notions.

Separate analyses were performed within the blind group which found differences in the gesticulation of children and young adults. Children have been found to gesture less than adults in both conditions; moreover, they gestured much less when describing abstract concepts (for abstract concepts, M = 1.70, SD = 1.76; for concrete concepts, M = 1.96, SD = 1.95). A plausible interpretation could be that gesticulation is closely intertwined with the understanding of abstract concepts, which is more difficult for primary than secondary school children. An alternative explanation of these results would be broad develop mental differences between the two age groups (e.g. Jaworska-Biskup 2011; Blass et al. 1974; Dunlea 1989; Fazzi et al. 1999).

5.2. Qualitative analysis: Gesture as epistemic action

The second question initially posed by the authors was whether gestures could be epistemic actions and, if so, which gestural strategies appeared to function as such. A detailed analysis of the gesticulation of blind participants was conducted, revealing several interesting phenomena. In this section the performance of all the participants will be discussed in more detail, with primary focus falling on three congenitally blind participants: one adult (female) and two children (one boy and one girl). Preliminary quantitative analysis showed that both groups of blind participants used gestures in their descriptions of abstract concepts, prompting the assumption that gesture may play a facilitative role in explaining non-directly embodied concepts.

A further question the authors sought to answer was which of the gesture types produced by early and congenitally blind and severely visually impaired youth appear to function as epistemic actions, externalising meaning through physical action so as to reduce the cognitive load. A quantitative analysis revealed that descriptions of abstract concepts were accompanied by blindisms, referential gestures, and an interesting phenomenon the researchers named simulations, or simulation gestures.

First, all participants in the congenitally blind group made frequent use of adaptors, in particular body- and finger-touching gestures. These gestures included, for instance, repeatedly rubbing two fingers together throughout a whole answer, pressing the fingers of one hand together and rhythmically rotating the fist, rubbing oneself with one finger or a whole hand, eye-pressing, pinching oneself, stroking one's leg or arm and swaying. Furthermore, one of the participants, a congenitally blind seven-year old girl, almost exclusively used her own body as gesture space. For example, she pretended to put an object down her shirt in order to explain the concept of luggage, while reenacting a scene where her father put her scooter into a car trunk; or pretended to write on her chest inside her shirt while explaining what an envelope is. These observations support the claims of Blass and colleagues (1974) that blind persons tend to engage in body-focused movements more than they do in object- focused movements, as well as Jaworska-Biskup's hypothesis that blind children's concept understanding is egocentric, or based on the idea of self as an object (Jaworska-Biskup 2011). Visual analysis of gesture also appears to support another claim of Blass, namely that finger-touching movements were correlated with verbal fluency, and that there is reverse correlation between fluency and body-touching. The

finding that all blind participants engaged in adaptor gestures seems to go in line with Kendon's suggestion that these gestures may perform an important, if currently underexplored, cognitive role. Nevertheless, blindisms did not appear to match the definition of epistemic actions. These gestures are likely to serve a cognitive purpose but did not appear to do so through externalisation of meaning. Further research is necessary to explore the potential of blindisms as a cognitive tool for blind and severely visually impaired learners.

Second, all of the participants in the older group, and one child in the younger group of blind and visually impaired children used referential gestures in their explanations. Studies demonstrate that the use of referential gesture by blind individuals does not differ significantly from that of the sighted (Iverson and Goldin-Meadow 1997, 2001). The presence of concrete referential gestures in the descriptions of concrete concepts performed by both blind and sighted young adults appears to go in line with previous findings. Metaphorical gestures, typically used in the descriptions of abstract concepts, were found to be rare to non-existent in the gestural repertoire of blind persons. They did appear, however, in some descriptions of abstract concepts produced by the blind and sighted participants in the present study. On the whole, the use of metaphorical gesture by blind participants was limited to the young adult group, with individual instances of metaphoric gesture used by one of the children (for example, a girl saying that software is heavy to explain the word *ciężar* 'heavy load', and mimicking lifting something heavy with her hands). Metaphorical gesture is closer to the definition of epistemic action in that it aids in the description of abstract concepts by mapping them onto concrete objects. The notion that metaphorical gestures may serve as epistemic actions is consistent with the GSA framework, which treats gestures as embodied simulations. However, another phenomenon in the gestural repertoire of the blind and seeing impaired group turned out to match the definition even closer.

Simulations, or simulation gesture is a term introduced in this paper, denoting gestures and speech that together constitute a reenactment of an event or scene, which the gesturer performs from a character viewpoint. They are similar to pantomime in that they reproduce rather than represent actions. However, unlike pantomime, simulations are accompanied by a full range of sound effects, including the speech of various characters involved in a scene (for example, one girl acted out a conversation between her mother, father and herself using different voices for each) and other sound effects (the sound of a closing car trunk, wailing of a baby, footsteps). Simulations resemble referential gestures in that

they convey information through both gesture and speech. However, in contrast to referential gestures, simulation gestures do not use physical objects as referents for a given concept, but rather provide an example of a situation that in the speaker's mind is representative of the phenomenon being described. For instance, we recorded one young adult pretending to look into a wallet, find nothing and walk to a bank to get a loan as an explanation for the word *kryzys* 'crisis'. This simulation included third person narration ("Crisis it is something very bad"), character dialogue ("Uh-oh. My wallet is empty"), sound effects (mimicking the sound of footsteps by tapping on the table with open palms), referential gesture (pretending to look into an empty wallet by holding out both hands in front of his face, posed as if holding, and subsequently opening a wallet") and was accompanied by blindisms. Another example is a girl who described the concept of life by screaming like a newborn and then immediately cooing softly like her mother, while pretending to hold a baby in her arms. Although they did appear in the descriptions of both types of concepts, simulations were a particularly prominent strategy in abstract concept explanations. In the view of the authors, such simulations appear to have the biggest potential as epistemic actions for three reasons. First, they constitute simulated actions, in that the participants clearly simulated the actions of people involved in a given event. Second, they were clearly meant to simplify the process of description, particularly in the case of abstract concepts with no direct physical referent. Finally, they were present in the gestural repertoire of blind but not sighted participants which could mean that they were cognitive coping strategies that developed in the absence of a visual model for other gesture types.

6. Conclusions and discussion

The authors asked whether gesture can be viewed as epistemic action in the performance of blind persons, and which type of gesture has the greatest potential to be classified as such. It appears that gestures, in particular simulations and metaphorical gestures of blind persons, can be interpreted as having a cognitive component, externalising meaning and aiding the gesturer's performance on a cognitive task making them fulfill the criteria set out for epistemic actions. These findings are in line with, and can be interpreted to extend the GSA framework, situating simulation gestures in the larger cognitive system, which includes mental imagery, embodied simulations of perception and action, and language production.

While the preliminary analysis of the results of this study yields some conclusions that are equally exciting as they are promising, care must be taken not to overgeneralise the findings. Blind persons, both as a social group and within the presented study, exhibit great individual variation in terms of gesture. Furthermore, their education, knowledge levels and vocabulary may also be significantly different from that of their sighted peers, which necessarily needs to influence any analysis of their conceptual processing.

In the course of this research project care was taken to isolate spontaneous gestures with a cognitive component. Nevertheless, it needs to be noted that all blind participants had some experience with revalidation training for the blind. Revalidation, which is a type of course aiming to make blind students appear more like their sighted peers, instructs students on their body language. This may have had an indirect impact on the gestural behaviours of children involved in such classes. Care must be taken to interpret the obtained results with reference to the specific context in which they were obtained. The scope of the presented analysis prohibits it from being anything but an introductory look into the fascinating world of spontaneous cognitive gesture used by blind youth. The authors hope that further research will follow the hypotheses presented in this study.

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