Explanandum and visibility condition change children’s gesture profiles during explanation: implications for learning?

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Abstract: We show how 6-year old first-graders’ gesture profiles evolve with both the type of explanandum and whether or not their interlocutor is visible. Sixty participants played two online educational games: one on numbers and the other involving manual dexterity. Our analyses focused on how 30 child-instructors explained both games to 30 child-learners in either one of two conditions: 1) face-to-face or 2) separated by a curtain. Our results give evidence for a multimodal view of language production that is closely tied to context. We show how some gestures remain stable across explanatory tasks, irrespective of interactional situations but how other gestures remain stable across interactional situations. We suggest implications for teaching-learning situations regarding gestured explanations.

Introduction and Theoretical Framework
We set out to see how the elaboration of gestures evolves with explanation task and interactional condition for 6-years olds, a population whose language and gesture skills are developing. We chose the context of “how” explanation production because researchers have mostly focused on “why” explanation production and we built an experimental situation where two different on-line game types were explained (the variable of context is tested) in two different interactional conditions (the variable of visibility is tested).

We argue for a model of multimodal language production where both verbal productions and gestures are influenced by the context in which they are produced and are co-elaborated as human interaction proceeds. We present a brief typology of both explanations and gestures and present our theoretical hypotheses concerning gesture production for “how” explanations depending on both task content and interactional situation. Both gestures (Alibali, Kita & Young, 2000; Cook, Mitchell & Goldin-Meadow, 2008) and explanations (e.g. de Vries, Lund & Baker, 2002) are well known for their positive role in aiding learners’ conceptualization and in this paper, we hypothesize how their context of production can influence that role.

The Role of Gestures in Models of Language Production and Comprehension
Gestures can help to understand the production and the comprehension of language. The message that commands movement corresponds to an “early step in the production process” (Colletta, 2007, p. 21) and in this view, gestures would be elaborated when the verbal message is conceptualized (McNeill, 1992; Kita, 2000). According to this “interface hypothesis”, gestures as well as language help in the development of one’s thinking in order to produce language, but also help others to understand one’s language (Kita, 2000). Gestures are thus generated in relation to speech within a spatio-motor representation organized with the goal of speaking (Kita, 2000; Kita & Özyürek, 2003); this model is based on the Growth Point theory of McNeill (1992:200).

Explanation and Gesture Typology
Explanation appears very early during child development and evolves during childhood (Colletta & Pellenq, 2009; Veneziano & Hudelot, 2002). Children are capable of coherent and cohesive discourse at ten or eleven years old (e.g. Mazur-Palandre, 2009). Explanation is an interesting theme as it is difficult to define linguistically. If the researchers that work on explanation agree that explanation is organized around an explanandum (phenomenon or behavior to explain and an explanans (cause, reason, motive – that which explains) (Hempel & Oppenheim, 1948; Lund, 2003), they do not deny that the verb “to explain” is polysemiotic. Grize (1990) gives six definitions: (1) communicate, (2) develop (3) teach, (4) interpret, (5) motivate and (6) give an account for. According to Grize, explanation can respond to three questions: what, how, and why? One of the originalities of our study is that we concentrate on “how” explanations, corresponding to the type of explanation “to teach” in Grize’s typology, very little studied for a child population.

Gestures can be classified into two large categories: autonomous gestures (or quasi-linguistic gestures, Cosnier (2008)) and co-verbal gestures (amongst others, Colletta, 2007; Cosnier 2008; Kendon, 2004; McNeill, 1992). We focus in particular on co-verbal gestures for this study and focus on the following gesture typology: deictic gesture (pointing gesture), representational gesture (represents a concrete object), framing gesture (expresses an emotional or mental state of the speaker), discursive gesture (structures the discourse), interactive gesture (verifies the attention of one’s interlocutor), enunciative gesture (expresses word searching) and
performative gesture (non-verbal language act that modifies the illocutionary force (i.e. speaker’s intentions; Austin, 1962) of the spoken word it accompanies).

The aforementioned multimodal model of language production and the descriptions we have given of both gestures and explanation types allow us to present our theoretical and operational hypotheses.

**Theoretical and Operational Hypotheses**

First, Colletta & Pelleng (2009) showed that depending on the type of context — narration, description or argumentation, children’s posture-mimo-gestuality specializes. For instance, during narrative and descriptive production, children produce more concrete gestures, whereas during argument production, they produce more interactive gestures. So, although both games are explained with “how” explanations, will the explanandum have an effect on gesture production, in particular since the spatial game seems to call for gesturing?

Second, research illustrates the importance of the interlocutor’s visibility on adults’ gesture production (among others, Alibali, Heath & Myers, 2001; Bavelas, 1994; Bavelas, Chovil, Lawrie & Wade, 1992). Such results confirm Kendon’s theory (1987) that the conditions of transmission have an important impact on both linguistic units and gestures. However, to our knowledge only one study concerning children confirms an effect of visibility on gestures (Doherty-Sneddon & Kent, 1996). And it states that only older children are sensitive to this factor. So will our 6-year old children gesture differently according to the visibility of their interlocutor?

Third, in previous studies, authors underline that gesture does not always have the same function. Gesture could both help the elaboration of the message by the speaker and the comprehension of the message by the interlocutor (Kita, 2000; Kita & Özyürekg, 2003; Kita, et al., 2007; Lozano & Tversky, 2006). Is it thus possible to distinguish gestures performed in order to help the elaboration of the message from gestures performed in order to facilitate the comprehension of the message by the interlocutor?

These theoretical hypotheses are captured in three operational hypotheses: OH1, OH2 and OH3. First, we expect that depending on the game played (explanandum), gesture profiles will be different (OH1). Secondly, depending on the visibility condition, gesture profiles will be different (OH2). Third, if OH2 is validated, we may see which gestures are geared more for production and which for communication (OH3).

**Methodology**

Here, we first describe our population and our protocol. Second, we illustrate how we performed our analyses by describing how we coded speaker gestures during explanation.

All of the first-graders in three schools in France (130 students) filled out a questionnaire from which we selected the participants of our study. All of the children were French native speakers, non-bilingual and did not have any behavioral or learning problems. 60 students participated: 30 girls and 30 boys (mean age: 6.6 years; standard deviation: 4.7 months. The children had parental authorization and participated voluntarily.

We filmed the students during regular classroom hours inside their school buildings. Children worked in pairs; each one played the role of either child-instructor or child-learner. In phase 1, the child-instructor was first asked to play a game (either the number or spatial game). After having played, the child-instructor explained the game to the child-learner (phase 2, the focus of our analyses for this article). Next, the child-learner played the game under the watch of the child-instructor (phase 3). The two games played are part of CogniKizz Net, a French on-line educational game site from www.cognik.net. All children played both games: “race to the numbers” (a player is asked to recognize numbers or count objects by clicking on the correct image) and “break the bricks” (the player must hit back a ball with the help of a kind of racket). The experiment was carried out under two conditions: children were either face-to-face or were separated by a curtain.

Transcription and coding of gestures was done in ELAN™. A movement is identified as a gesture when it is sufficiently noticeable (high amplitude and visible by the interlocutor). Only hand and head gestures were taken into consideration (no leg and trunk movements, nor self-focus gestures were coded). Once the movements were tagged as gestures, one coder categorized them according to whether they were Deictic, Representational, Framing, Discursive, Interactive, Word-searching or Performative gestures (as described in the section on Gesture typology). Inter coder reliability calculations are in progress.

**Results**

Four sets of aggregated gesture profiles are shown: Figure 1 reflects explanations given by the child-instructor to the child-learner for the spatial game and Figure 2 does so for the numbers game. In both figures, the face-to-face condition is on the left and the separated condition is on the right. In all the graphs, the x-axis shows gesture types and the y-axis shows the percentage scale. The error bars represent the standard deviation, often quite large in studies on children’s language acquisition. Proportions are regrouped in Tables 1 and 2; bold type shows the highest values.

The amount of discursive and word searching gestures produced while explaining the spatial game is dependent on the visibility condition (OH2 is confirmed and elements are given for OH3; cf. Figure 1). The amount of interactive, representational and word searching gestures produced while explaining the numbers
game is dependent on the visibility condition (OH2 is confirmed and elements are given for OH3; cf. Figure 2). Also, OH1 is confirmed: depending on the explanandum (game explained), gesture profiles are different.

![Figure 1](image1.png)

Figure 1. The proportion in percentages of gesture types in the spatial game in the two conditions

Table 1. Proportions of gestures while explaining the spatial game according to the visibility condition

<table>
<thead>
<tr>
<th>Gesture type</th>
<th>Representational</th>
<th>Discursive</th>
<th>Interactive</th>
<th>Word searching</th>
<th>Deictic</th>
<th>Performative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>38.62%</td>
<td>35.46%</td>
<td>12.01%</td>
<td>9.07%</td>
<td>4.1%</td>
<td>0.74%</td>
</tr>
<tr>
<td>Separated</td>
<td>44.86%</td>
<td>22.13%</td>
<td>10.7%</td>
<td>22.31%</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>

![Figure 2](image2.png)

Figure 2. The proportion in percentage of gesture types in the number game in the two conditions

Table 2. Proportions of gestures while explaining the number game according to the visibility condition

<table>
<thead>
<tr>
<th>Gesture type</th>
<th>Representational</th>
<th>Discursive</th>
<th>Interactive</th>
<th>Word searching</th>
<th>Deictic</th>
<th>Performative</th>
<th>Framing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>22.14%</td>
<td>32.47%</td>
<td>28.69%</td>
<td>8.55%</td>
<td>6.67%</td>
<td>1.48%</td>
<td>/</td>
</tr>
<tr>
<td>Separated</td>
<td>7.2%</td>
<td>40.42%</td>
<td>19.63%</td>
<td>28.62%</td>
<td>/</td>
<td>/</td>
<td>3.70%</td>
</tr>
</tbody>
</table>

**Discussion, Conclusion and Perspectives**

When child-instructors explain the spatial game to child-learners, the majority gesture type is representational irrespective of visibility condition (cf. Table 3, results a and b). The fact that explaining a spatial task leads to representational gestures validates both OH1 and aligns with Kita & Özyürek’s (2003) multimodal model of language production; if a spoken production contains notions of spatiality, then more representational gestures will be produced, as both verbal and gestural aspects are co-elaborated (c.f. Bergmann & Kopp, 2008).

Table 3: Syntheses of results concerning the 60 child explanations, taken up in order in the discussion

<table>
<thead>
<tr>
<th>Absence of visibility</th>
<th>Explaining the spatial game</th>
<th>Explaining the numbers game</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. Majority of representational gestures</td>
<td>e. Majority of discursive gestures</td>
</tr>
<tr>
<td></td>
<td>b. Majority of representational gestures</td>
<td>f. Majority of discursive gestures</td>
</tr>
<tr>
<td>Face-to-face condition</td>
<td>c. Less discursive gestures</td>
<td>d. More discursive gestures</td>
</tr>
</tbody>
</table>
But Kita and Özyürek’s model also states that language production depends on context and communicative goal and our results show that representational gestures remain stable even though visibility changes. Either representational gestures are important for both producing and comprehending messages or the explanandum type overrides the visibility condition. If visibility doesn’t influence representational gesture production, this argues against a generalized OH2 whereas our other results report that the visibility condition does give different gesture profiles. Other research, but concerning adults also shows that visibility can indeed have an impact on the proportion of certain gestures. For example, Bavelas et al. (1992, 1994) have identical results to ours; adult speakers perform more interactive gestures in the face-to-face condition and they perform as many “topic” gestures (considered as equivalent to our representational gestures) in the face-to-face condition as in the separated condition. On the other hand, Alibali et al. (2001) shows contrary results to ours (but again, for adults): representational gestures depend on the visibility condition whereas beats (gestures that are synchronized with speech rhythm and emphasize words or phrases) have the same proportion regardless of the visibility condition. However, the explanandum was a cartoon to be narrated and not a spatial game to be explained, so gesture impetus differed.

Another explanation for representational gestures in the spatial game remaining the same regardless of visibility condition (other than the force of representational gestures) could be that children of our study are too young to be sensitive to visibility. Indeed, Doherty-Sneddon and Kent (1996) show that six-year olds perform the same proportion of gestures in the two conditions (face-to-face and separated) whereas eleven-year olds make more communicative gestures in the face-to-face condition. But these results call for prudence insofar as no distinction is made between different communicative gestures and the gestures counted in the separated condition include those where children stand up in order to be seen, thus eliminating the visibility condition.

Now consider the following two results: there are more discursive gestures when explaining the spatial game in the face-to-face condition as opposed to the separated condition (cf. Table 3, results c and d; OH2 confirmed) whereas when our child-instructors explain the numbers game to child-learners, the type of gesture they produce the most is discursive, but there is no distinction between visibility conditions (cf. Table 3, results e and f; argues against OH2). This difference in discursive gesture production according to visibility condition between the two games could perhaps again be explained by the explanandum nature: it makes sense to emphasize linguistic units having to do with breaking bricks when face-to-face because the action involved is visually shared. In the numbers task, there is an action of selecting a picture, but not of carrying out movement. The relative prevalence of discursive gestures (unless overridden by a spatial explanation task) is confirmed by Colletta & Pellencq (2009) who found that during “why” explanations on social and family topics, children from a similar age group as ours produced a majority of discursive gestures, when speaking to an experimenter. But then, must we choose in an either-or situation? Is it that either children are sensitive to the visibility condition (more discursive gestures in the face-to-face condition for the spatial task) or they are not (amount of representational gestures are highest for the spatial task and amount of discursive gestures are highest for the numbers game, both regardless of condition). Alternatively, perhaps the nature of the explanatory task that children accomplish determines their level of sensitivity to the visibility condition (a crossing of OH1 & OH2).

If we continue to compare the interactional conditions, we first observe that word-searching gestures are the 2nd most produced for explaining both the spatial game and the numbers game in the separated condition whereas they are the 4th most produced for both games, face-to-face (cf. Table 3, results g, h, i and j). Is it that being blocked from seeing one’s interlocutor hinders “how” explanation production and forces speakers to perform lexical or syntactic searches (OH2)? Second, deictic gestures only occur in the face-to-face condition (OH3); they seem to be specifically produced to facilitate the interlocutor’s comprehension of the message (cf. Table 3, result k). Third, interactive gestures diminish strongly in the separated condition, but still exist (cf. Table 3, result l). Are they mostly for facilitating message comprehension, yet pertinent for production (OH3)?

We have shown that the context of young children’s explanation production (explanandum type + visibility condition) changes their gesture profiles; how can this result influence the positive role both explanation and gestures have on learners’ conceptualization? In this short paper, we can only invoke our perspectives for further research. A study from Cook, Mitchell & Goldin-Meadow (2008) shows how gesturing during problem solving makes for longer lasting learning gains, but perhaps the explanandum, the visibility condition and the type of gesture performed makes a difference for such learning gains. In summary, the multimodal model of language production argues that gestures are done both for production and comprehension (Lozano & Tversky, 2006) but we show that this is true to different degrees, depending on both explanandum

<table>
<thead>
<tr>
<th>Absence of visibility</th>
<th>g. Word-searching gestures 2nd most produced</th>
<th>h. Word-searching gestures 2nd most produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face condition</td>
<td>i. Word-searching gestures 4th most produced</td>
<td>j. Word-searching gestures 4th most produced</td>
</tr>
</tbody>
</table>

h. Word-searching gestures 2nd most produced
and visibility condition. Understanding the factors that influence speakers’ gesture production while knowing that gestures are important for conceptualization (Alibali, Kita & Young, 2000), should help us to design more effective teaching-learning tasks that are built around explanation.

References

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