

# How Designers Express Agreement

The role of multimodal communication in communicating agreement and reaching shared understanding during conceptual design.

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In this paper, we present a study on the role of verbal communication in reaching shared understanding during idea generation in design teams. More specifically, our goal is to investigate specific communication actions designers take in different communication modalities that lead to shared understanding. In order to realize this goal, we conducted a quasi-experimental with 18 participants, who designed in groups of 3. The control groups communicated freely, whereas the test groups were not allowed to use verbal communication. We identified and analyzed communication actions that represent agreement in four different modalities: gestural, verbal, graphical and textual communication. The results suggest that in the absence of verbalization, groups rely on concepts that are generated primarily by individuals, and do not negotiate the type of shared understanding that leads to the co-creation of new concepts. When verbalization is allowed, they are more likely to build on and advance concepts that are generated by individuals to construct that type of shared understanding, and conceptualize collectively.

***Key words: Sketching, Shared-understanding, Multi-modal Communication, Design thinking***

## 1. Introduction

Designing is a cognitive activity [18,20]. Starting with the first step of the design process, problem framing, designers construct and negotiate mental representations of the problem and its potential solutions. These representations are dependent on the designer's knowledge and expertise. However, since existing knowledge is usually not sufficient for generating a solution, further information must be acquired and integrated into representations. New and often contradicting information must be integrated into the problem solving process, which requires designers to constantly analyze and adapt their mental representations. The problem and solution representations are interrelated and have direct consequences on the outcome, the product. A variety of complex and uncertain decisions characterize that rich dialog [8].

When solving complex design problems, designers engage in several activities. A key activity is framing the problem they are facing. This involves analyzing the problem and searching for possible solutions—these two activities are often interlaced [7,12]. Once a satisfactory problem frame has been established, a decision has to be made to select the most appropriate solution among the possible solutions that have been generated. Sketching can play an important role for designers as a representation medium during these activities.

Designers and sketches are always in dialog; sketching is a central activity while designing [1,4]. Sketches are often the designer's medium for visualizing, verbalizing and transferring their thinking to oneself and to the team members [9,10,11]. Sketching also plays a role in the sharing of content and process specific information at both the individual and the team levels [2].

Sketches can be seen as having three functions. Firstly, they are an externalization and analysis mechanism, and simplify multi-faceted problems. Secondly, they are mediums of persuasion to "sell" ideas to stakeholders and reassure them that their "situation" is being correctly interpreted. Finally, when detailed, they constitute a method for communicating unambiguous information to those responsible for the product's manufacture, assembly and marketing [13].

In summary, most empirical studies reveal that sketching is a necessary part of the design process [19]. In addition to the functions outlined above, it can also be argued that the use of visual representations provides memory extension, which lowers the cognitive load of designers [14]. Therefore, designers who sketch during the design process perceive problems as more workable, and can infer more relations between components of complex concepts [15]. These findings suggest that sketches support the designer in reaching a better and deeper understanding of his/her own ideas.

Moreover, when sketching as a part of a group, designers use multimodal communication to transfer, communicate and visualize their thoughts. For instance, sketches themselves consist of graphical and textual information [6,9,10,11,19]. In addition, gesturing has been identified as an influential activity during collaborative design sketching [3,17].

Finally, in group settings, sketches provide a common ground, and thus lead to a shared focus of attention, which leads to better design collaboration and product performance [5]. Shared sketches serve as a common object of communication, and facilitate the interaction between the team members.

## **2. Research Questions and Hypothesis**

In this paper, we explore the following research questions:

1. Are the agreements reached while constructing shared understanding expressed through multi-modal communication? If so, what is the interplay between the different communication channels that are involved? Is there a dominant one?
2. What strategies are used by design teams in reaching shared understanding while sketching?

Moreover, we hypothesized that, when verbal communication is blocked, the other communication channels will be used more extensively to express agreement.

## **3. Empirical Study**

### **3.1 Data collection**

We conducted a quasi-experiment to explore the research questions, in which 18 participants responded to a design brief groups of 3. There were 3 teams in each of the control and test conditions.

In the test condition, which we termed "silent sketching," participants were not allowed to talk during the design task. In the control condition, which we termed "verbal sketching," communication was not restricted. All

participants were masters and doctoral students in the Industrial Design Engineering faculty of Delft University of Technology in The Netherlands.

### 3.2 The design task

As shown in the figure 1, the experiment consisted of two phases. In the first phase, participants responded to the design brief individually, without any collaboration with other group members for 20 minutes. In the second phase, they continued to work on the same design brief collaboratively, and arrived at one final concept after 50 minutes.

The task was to design a product that will enhance the cooking experience of blind people. At the beginning of Phase 1, they were asked to develop solutions that are novel and different from existing cooking products. At the beginning of Phase 2, they were asked to collaboratively work toward one final concept by the end of the experiment. In phase 1, they were provided with A3 size paper sheets and colored markers. In Phase 2, they were provided with A1 size paper sheets, which were meant to facilitate collaborative sketching. Also, they were asked to use the same color pen throughout the whole exercise. Finally, they were asked to fill in a survey about their self-perceived ability to communicate using different media.

All activities were audio visually recorded by using multiple cameras (figures 2 & 3), observed and analyzed. During the break after Phase 1, sketches produced by individuals were captured digitally to document their state before Phase 2 in case they might be developed/modified during collaboration.

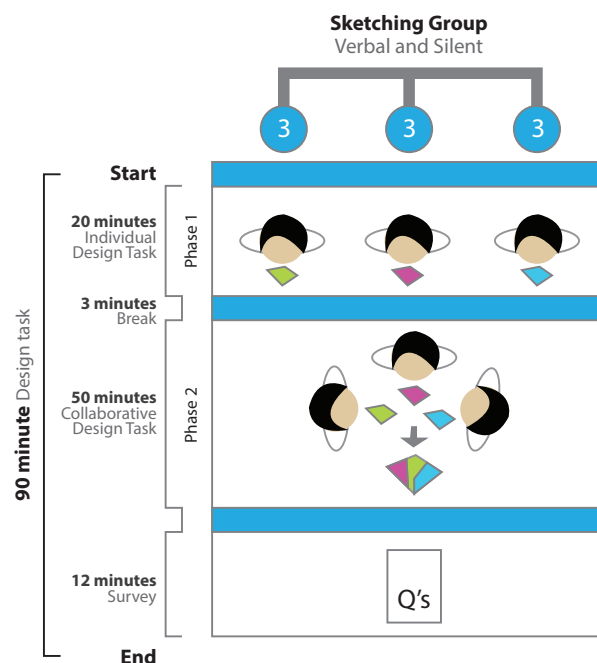


Figure 1. Overview and timeline of the experiment.

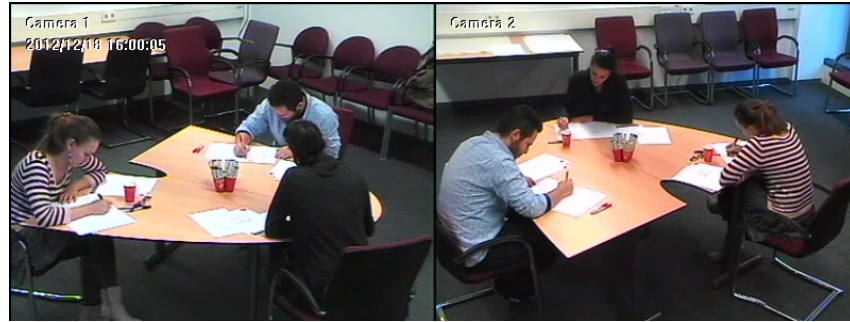


Figure 2. Representative still image from the side cameras



Figure 3. Representative still image from the top camera

### 3.3 Communication Activity Categorization

In order to understand if agreements reached while constructing shared understanding are expressed through multi-modal communication, we classified and analyzed the agreement actions that occurred in the following communication modalities:

1. Gestural
2. Verbal
3. Graphical
4. Textual

Gestural agreement entails the act of *pointing at sketch elements or at the person who communicated an idea, giving thumbs up, clapping, hugging or smiling*, after which no further changes were made to the sketch element under consideration. Verbal agreement entails saying *yes, yeah, okay, sure, exactly, or true*, after which no further changes were made to the sketch element under consideration. Textual agreement entails writing *okay, yes, true, cool!, done, you are right* on the sketch. Finally, graphic agreement entails drawing *checkmarks* on the sketch. The specific agreement actions defined above were the outcome of our analysis of all agreement actions that were made during the sessions, and constitute an emergent coding scheme. Also, in order to analyze temporal relationships, we time stamped all observed agreement actions.

## 4. Results

Since the study is focused on how design teams reach shared understanding and how agreements are communicated during design collaboration, Phase 1 was excluded from the analysis. We have not conducted statistical analysis to test for the significance of the differences that exist between the silent and non-silent groups because the number of groups in each experimental condition is small ( $n=3$ ) at this point in the project.

### 4.1 Agreement actions by communication modality

Each agreement was coded according to the communication channel in which it was expressed, and was assigned to a time interval based on when it occurred during the collaborative phase – the 50 minute session was divided into five 10 minute intervals.

Table 1 shows the cumulative counts of agreement actions for the verbal and silent sketching groups. The total number agreement actions were higher in the verbal sketching groups; 669 for the verbal sketching groups versus 114 for the silent sketching groups.

Table 1. Cumulative agreement actions by communication modality for verbal and silent sketching groups

Time (minute)	Type of agreements							
	Gestural		Verbal		Textual		Graphical	
	Verbal	Silent	Verbal	Silent	Verbal	Silent	Verbal	Silent
10	6	12	52	0	0	0	0	2
20	12	21	148	0	0	2	0	6
30	3	14	111	0	0	4	0	7
40	1	25	204	0	0	2	0	3
50	0	13	132	0	0	1	0	2

This information is plotted in Figure 4 as averages of agreement actions per group for each communication modality.

When verbal communication was possible, verbal agreement actions were dominant. When verbal communication was blocked, agreement actions were much lower as a whole. This drastic drop in agreement actions in the silent condition suggests that agreement was achieved either more efficiently through non-verbal actions, or to a much lesser extent. Another observation is that, verbal groups did not use textual or graphical information to express agreement, whereas silent groups used all available communication modalities (gestural, textual and graphical).

These results offer preliminary support for our hypothesis in that, when verbal communication channel was blocked, the other communication modalities were used more to express agreement.

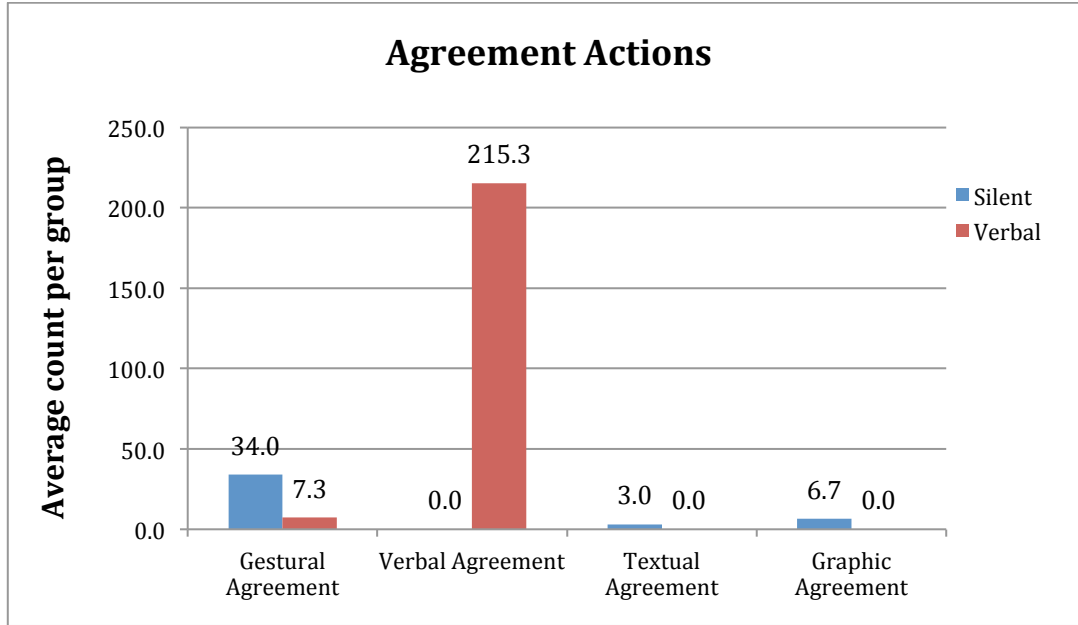


Figure 4. Average agreement actions per group for each communication modality

#### 4.2 Agreement actions over time

The large decrease in the total agreement actions in the silent condition prompted us to explore if silent groups expressed agreement more sparingly and efficiently—meaning, in situations when communicating agreement was critical. Our initial thinking was that groups had to express agreement during concept selection, which suggested that the few agreement actions that they took might be toward the end of the session. Therefore, we analysed how agreement actions manifested themselves over the course of each session by assigning each agreement action to a 10 minute interval and plotting the results over time (see Figures 4 and 5).

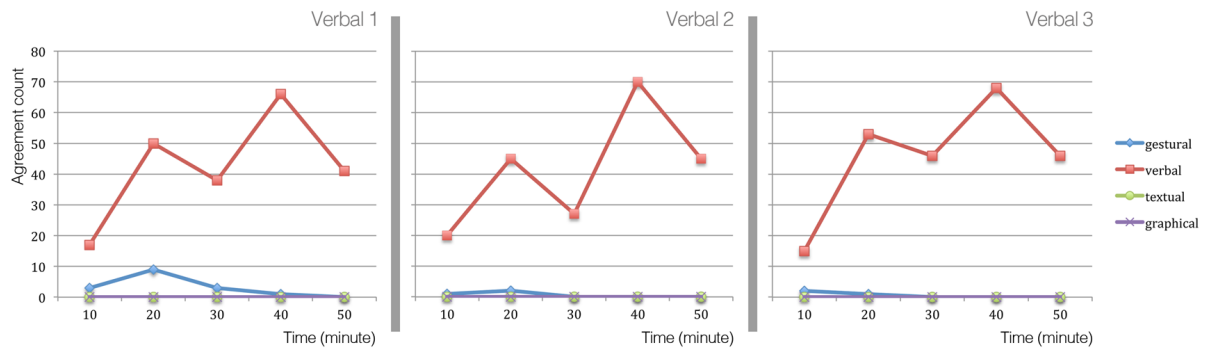


Figure 4. Agreement counts over session time for each verbal sketching group

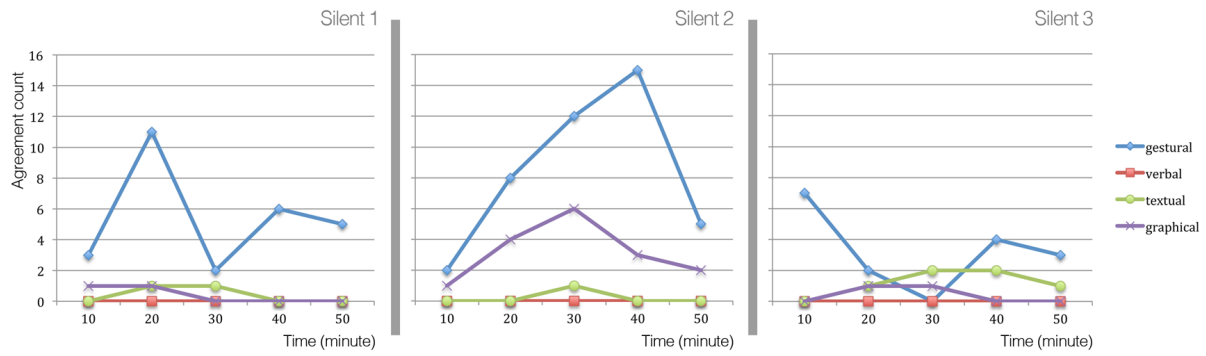


Figure 5. Agreement counts over session time for each silent sketching group

In the verbal groups, verbal agreement actions have an increasing trend over time with dips mid and close to the end of the session. This trend is surprisingly similar for all three verbal groups. This increasing trend is congruent with our expectation that more agreement actions would be taken toward the end of a session.

As stated above, we expected that trend to be even stronger in the silent groups. However, as can be seen in Figure 5, that was not the case for two of the three silent groups. This finding indeed suggested that the silent groups might have achieved agreement to a much lesser extent than the verbal groups, and consequently, might have constructed less shared understanding. This result prompted us to analyze the evolution of the content of the sketches to see how much synthesis and integration took place in the group discussion.

#### 4.3 Qualitative observation on how design teams reached shared understanding during idea generation in collaboration

Based on our analysis of how sketch contents evolved over time, we identified two different approaches (figure 6 and 7) for how design teams reached shared understanding during concept development. These patterns are expressed in terms of four previously identified basic cognitive operations - *generation*, *exploration*, *comparison* and *selection* [16].

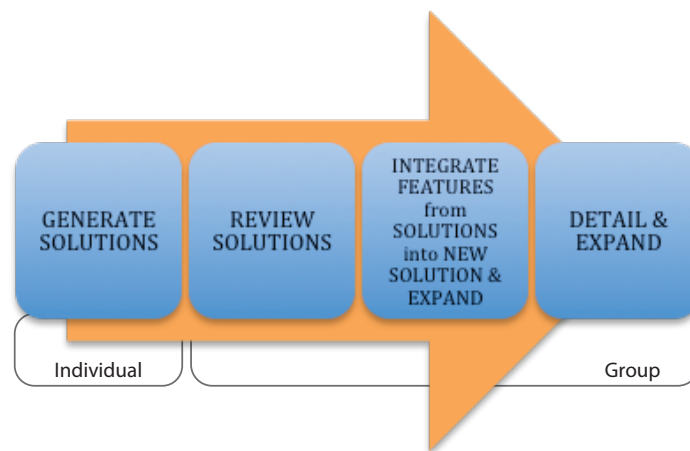


Figure 6. Pattern 1 in reaching shared understanding

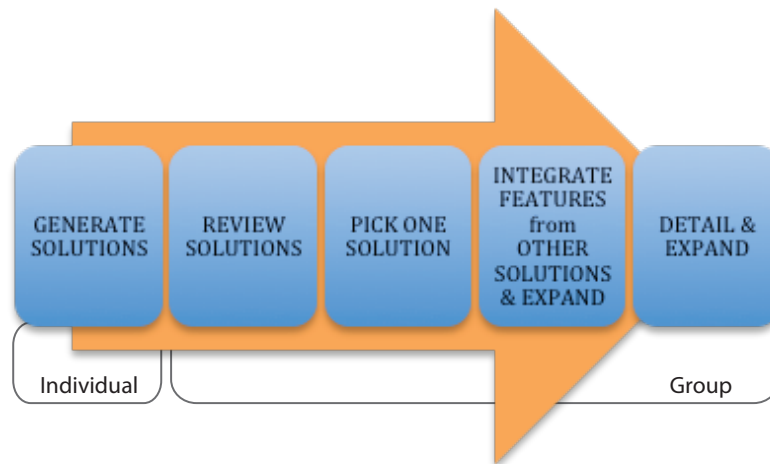


Figure 7. Pattern 2 in reaching shared understanding

Pattern 1 was more representative of the strategy employed by the silent groups, whereas Pattern 2 was more representative of the strategy employed by the verbal groups. The key distinction between the two approaches is that in Pattern 2, one of the concepts that were developed during the individual ideation phase is chosen and used as a template for the final solution without significant modification to the core idea, whereas in Pattern 1, several individual solutions are integrated to arrive at an idea that is significantly different from any of the individual ideas to form the basis for the final solution. This difference might explain the large decrease in the agreement actions in the silent group; early on the collaborative phase, they seem to have simply defaulted on a concept created by an individual during the individual phase, and thus, did not need to construct and agree on a shared understanding that incorporated the different perspectives.

## 5. Conclusions

As expected, blocking verbal communication led to designers relying more on the other communication channels—gestural, textual and graphical—in order to express agreement on product information under consideration. However, there was a large decrease in the number of total agreement actions, and our analysis suggest that this is mainly due to the groups not trying to build on and integrate each other’s ideas when verbal communication was not possible. When subjects designed in silence, the agreement actions they communicated seemed to be primarily about choosing one of the ideas that were generated by individuals prior to group collaboration.

Therefore, it seems that verbal communication plays a critical role in negotiating shared understanding and reaching agreement at a complex and integrative manner. This does not mean that the other communication modalities do not play a role; for instance, without drawing, there would be no shared representation to negotiate or reach agreement on, and gesturing seems to communicate additional information during that discussion. However, our preliminary findings suggest that agreement seems to be made explicit primarily through verbal communication during conceptual design.



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