Multi-modal interactions analysis to characterise co-creative design session

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Résumé :Co-creative sessions involve design teams, clients and end users. During these sessions, a large variety of design representations are used. This paper focuses on the current practice of co-creative sessions by analyzing discussion and interactions between designers and clients. For this purpose, we recorded a meeting where we analyze the speech and different types of gestures occurring between participants using multiple artefacts (tangible, digital and virtual). Finally, an analysis combining both methods was carried out. The results confirm that artefacts played a significant role in the co-creative process and when those artefacts are missing participants simulate their need through gestures in thin air called imaginary artefact. The results also show that more than one artefact can be involved at the same interaction, this what we call Multiple marker. It also spots the fact that more than one interaction can happen at the same time, called aside marker which allow us to distinguish the principal interaction from the secondary ones.

Mots-clés—co-design, gestures interactions,verbal interactions

I. INTRODUCTION

Co-design, meant as the active involvement of customers, end-users and other relevant stakeholders in a collaborative design session, is gaining more and more attention both in academic research and in industrial practice. Indeed, it promises to direct design activities towards the fulfilment of well-focused needs, with intrinsic attention to usability issues and with the potential to take into account functional as well as emotional expectations of involved users. However, whoever has participated to a collaborative design session recognizes that the communication among design actors with significantly different background and competencies cannot be managed with the same methodological approach and modelling tools typically used by expert practitioners. In actuality, language barriers, but also differences in imagination and interpretation abilities or representation skills, require following suitably tailored design processes and exchanging thoughts through more inclusive means. In this context, the SPARK project (http://spark-project.net/), funded by the European Union's Horizon 2020 Research and Innovation programme, aims at facilitating the creative interaction within collaborative design sessions by providing a responsive ICT platform based on Spatial Augmented Reality (SAR) that allows creating, visualizing, assessing and modifying design concepts since the earliest stages of a design process. Due to the intrinsic characteristics of SAR, SPARK platform is suitable to represent superficial features of a design object; besides, it allows visualizing, in real time, 3D tangible real-scale mixed prototypes easy to interpret also by non-experts. In other terms, the aim is to reduce the cognitive barriers between heterogeneous participants to a design session. Example target groups and applications of the SPARK technology are creative companies working on packaging design (e.g., for communication clarity and appeal of consumer products) and interaction designers working on industrial design products (e.g., for ergonomics, usability and appeal of household appliances). Therefore, SPARK partners have the chance to observe design sessions that can get significant advantages from the involvement of product end-users. Within them, the correct interpretation of the design session dynamics is of paramount importance to properly develop the supporting ICT technology. More in detail, it is necessary to analyse both verbal and gesture interactions to explore the behaviour of the participants in a co-design session and to understand what works, what brings to more creative outcomes. Unfortunately, despite the large literature dedicated to the analysis of processes occurring in a design session, spoken interactions and gestures of participants are typically considered as separate entities, and there are no established approaches to perform the characterization of collaborative design sessions through the joint analysis of what participants say and do. This paper proposes a step ahead in this direction by describing and analysing a co-design session in a real context (in-situ) dedicated to the design of a packaging for organic biscuits

involving three professional creative designers, two representatives of the client company and five representative end-customers. The study shows how designers and non-designers focus their attention on different features; as well, they interact with each other and with/through design representations in a quite different way. The same approach to the analysis of co-design sessions appears as relevant to apply to other contexts so as to gain a better understanding of collaboration dynamics. The paper follows with a brief overview of gesture and speech analysis of collaborative design sessions with the aim of highlighting what is already established in the design community and what is missing. Section 3 presents the case study, the context where the co-design session was recorded and the details of the specific design task. Then, after describing the coding schemes for gesture and speech analysis in section 4, the results of the joint analysis are presented and discussed in the last two sections.

II. STATE OF THE ART

Interaction Analysis is defined by Jordan& Henderson (1995) as: "an interdisciplinary method for the empirical investigation of the interaction of human beings with each other and with objects in their environment. It investigates human activities such as talk, nonverbal interaction, and the use of artifacts and technologies, identifying routine practices and problems and the resources for their solution". During a co-design session, debates are structured upon multiple representations of the alternatives. Participants are usually seeking two objectives: agreement about existing proposals or definition of modifications based on the existing proposals. In our context, interaction analysis focuses on interactions between clients and designers, supported or not by an artefact, but also on interactions between a client (or a designer), for instance, with a physical mock-up when the former manipulates or observe it. An interaction can, therefore, be verbal (i.e. supported by speech), physical (i.e. supported by gesture), or both, and involves at least two people or a person and an artifact. What do we call artefact? Designers consider and manipulate a lot of objects during design sessions (Vink, 2011). Several names are used to describe these objects: mock-ups, prototypes, representations, objects, resources, etc. All these different terms involve different levels of generality or particularity, describing a set or subset of objects of the world. Our observations show two main categories of elements that are used by designers: elements dedicated to the description of the designed object and elements dedicated to the description of the environment or the context of use of the designed object. We propose to consider two categories: design representation (Pei, 2009) and external resources. Therefore, for the analysis of the design sessions, in order to reduce the ambiguity, we chose to include all these elements in the same category named Artefact. Among this category, we differentiate tangible and digital artefacts. A digital representation may be a 2D or 3D computerised representation, a picture, an image, a shape rendering, whatever is displayed on a digital screen, like a computer or HD television. A tangible representation will be any object that helps the creation, the understanding, the explanation of the concepts as long as it is tangible. Hand sketches on paper, printed 2D drawings, printed photos, 3D physical mock-ups, prototypes are considered as tangible artefacts. In this paper, the characterisation of a co-design session intends to provide evidences of the types of interactions (Who interacts with whom? Which artefacts are involved in these interactions?) and the purpose of these interactions (Which actions are undertaken in these interactions?). Literature shows that authors confronted to these questions often rely on two complementary approaches: verbal and gestural interaction analysis. Mc Neil (2005) asserts that gestures are closely linked to speech and that gestures analysis is useful because they include all idiosyncratic spontaneous movements of hands and harms while speaking. In the field of virtual reality, considering people using gestures and speech to manipulate graphic images on a computer screen, Hauptmann and Mac Avinney (1993) concluded there was uniformity in the way people communicate with both gestures and speech. In the field of design, Suwa and Tversky (1999) highlight the importance of capturing visual data, including gestures, to capture missing elements in verbal data and to clarify verbal ambiguities. Despite these authoritative references that might have opened a research thread toward the joint study of gesture and speech in co-design session, we could not find significant contributions on this topic in scientific literature. This is the essential motivation for the research activity here presented. 2.1 Gesture interaction categorization in design Gestures have been widely studied for several purposes: communication, creativity and cognitive process, human-machine interfaces development, etc. Authors often refer to Mac Neill (1992) who identifies four categories of gestures: iconic, metaphoric, deictic and beat gestures. In the field of cognitive design research, Visser (2010) proposed an analysis of interaction modalities in professional collaboration and particularly tried to characterize the link between form and function of gestures in architectural design meetings. This study highlighted the multifaceted nature of gestures and consequently the difficulty to grasp functional and form categories of gestures. Davis (2016), who focused on early stages of the design process, kept only two categories: iconic and metaphoric. She concluded on the importance of metaphoric gesticulations to support communication of solution-scenarios. Most of these studies focused on designer's activities held during the production of design representation (sketching…). We consider here a wider context, as the observed situations are involving existing artefacts, as well as they can potentially lead to the modification of design representations. 2.2 Speech interaction categorization in design The largest majority of analyses of spoken interactions among designers belong to the domain of design protocol studies. Such behavioural studies observe designers as they talk to each other in collaborative sessions (conversational protocols), or as an individual is asked to say what his/her thoughts are (think aloud individual protocols) or were (ex-post individual protocols) (Jiang and Yen, 2009). This clearly shows that design protocol analyses mainly aim at capturing relevant insights about phenomena, as

reviewed in Cross (2001), and cognitive processes characterizing the design activity, as reviewed in Hay et al (2016). Whatever the goal of protocol studies is, the process to carry them out follows a standard procedure: after the definition of a coding scheme to characterize what happens during the design session (i), the activity of designers gets recorded (ii) and transcribed (iii). Then, the transcription of the design discourse gets segmented and classified according to the initially defined coding scheme (iv), which makes the data ready for the analysis (v) and the extraction of relevant conclusions (vi). Therefore, the results of a speech analysis on design protocol strictly depends on the main constructs of the coding scheme. Beyond design, coding schemes for content analysis spread over different domains, including live or virtual spoken interactions. Their review goes beyond the purpose of the current paper, as a tailored coding scheme for analysing the content of spoken interaction has been developed consistently with the goals of the SPARK project, as presented in section 4.2. Both gesture analysis and speech analysis have proven to be very efficient in the understanding of design cognition. However they surprisingly remained distinct. Therefore, the understanding of the role of artefacts on co-design cognition remained poorly studied and gesture analysis limited to communication studies. Our research question investigates the role of gestures through and with artefacts and the impact on the co-design process. This is why we need to have access to the verbalizations in order to understand the purpose of the corresponding interactions together with the analysis of gestures and artefacts. We call this method a joint analysis and this is the main original contribution of the paper.

III. DESCRIPTION OF THE CASE STUDY

The case study here analysed is a co-design session involving designers, their clients and end-users. During the session, designers presented the outcome of their previous work and exposed the proposals to the clients; in return, they collected client's and end-users' feedbacks and managed a joint discussion on possible improvements, as well as new alternative may emerge. During the session, stakeholders used different instruments such as paper, pencil, screenshots, laptops, projections, mock-ups, catalogues of the brand, sticky-notes, etc. The co-design session was recorded at ARTEFICE, an Italian consulting company specialised in branding design and communication. The client of this case study was ALCE NERO Company, which is the brand name of a consortium of organic farmers and processors that transform raw materials from organic agriculture into high quality food products.

Figure 1. (A) INSTALLED EQUIPMENT RECORDING THE SESSION (B) DISCUSSION BETWEEN DESIGNERS AND CLIENTS (C) TANGIBLE MOCK-UPS DISCUSSED WITH RED AND GREEN STICKY-NOTES

In addition to the three designers from Artefice, the meeting involved two clients' representatives and five end-users (figure 1, b). The designers did not discuss any basic graphic design elements (text, logo, image…) already validated by the clients in previous meetings; only suggestions on the final layout of the packaging were expected (position, size, colours…). The session was organised into four phases and the paper concentrates on the second one, where the designers are presenting four alternative concepts, each concept being implemented for a specific type of biscuit and the associated packaging. During this episode, the end-users' opinions are collected using red and green sticky-notes (figure 1, c), standing for positive and negative arguments related to each packaging alternative. The equipment used to record the session was 4 High Definition cameras, broadcasted through Tricaster into an observation room, where the research team could observe the entire session. The cameras were covering at best the entire scene and taking into consideration specific requirements of the session mentioned by our partners (figure 1, a). These requirements were based on the meeting room configuration, the seating arrangement and information about the use of specific devices (TV, whiteboard for sticky notes, vertical multi-touch screen...). We also provided participants with personal lapel-microphones in order to have a high quality sound capture for each participant. We also installed an ambient microphone to cover the whole room. All the participants were informed about the study and agreed to be recorded during the meeting. We also drew the map of participant's position, of the artefacts used, and of the camera and furniture present in the room. After the session data has been post-processed (encoding, synchronisation, formatting, etc..) to enable researchers analysing the data collected under a 4 screen format synchronised with the sound. Then two transcriptions have been done, one describing gestures and a second for speech.

IV. CODING SCHEMES DESCRIPTION

A. Coding scheme for gestures

As described in section 2, the literature study showed that gesture analysis has been at the centre of some important studies. However this literature does not provide a relevant framework for supporting this interaction analysis from the point of view of the effect they have on the design object. We have a functional approach of gestures rather than a cognitive one. Therefore, we created our own analysis coding scheme that we tested during a pilot session in the same company on another project. It is based on three elements: the client(s), the designer(s) and the artefact(s) used to support their interactions. This led to two groups of interactions: 1) with artefact (interactions 2, 3 and 4, figure 2) and 2) without artefact (1, 5

and 6, figure 2). In the case of designers/clients interactions we put a special emphasis on the originator of the interaction: 'a' when the client was initiating the interaction, 'b' in the other case. Each interaction supported by an artefact was subdivided into two categories: digital and tangible. In this context the digital artefacts category included any kind of representation displayed on the multi-touch screen and the tangible artefact category included physical packaging mock-ups, printed sheets of the packaging alternatives drawings, sticky-notes that will be posted on the white board, or personal note. A first attempt for coding interactions with this first version of the coding scheme did not allow us to code all gestures that we observed.

ITEMS		FEATURES	
Coding scheme about items	**Speech parts referring to elements on the design proposal characterized by …**	**Coding scheme about features of items**	**Speech parts referring to parameters of items on the design proposal concerning the…**
Texture	…background motifs/patterns	Position	…geographical location
Logo	…brand distinctive graphics	Orientation	…degree of rotation
Image	…a computer generated picture	Size	…length, width and/or depth
Photograph	…a photograph of a real object	Number	…the amount of items
Text	…what expressed by words	Content	…conveyed information
Icon	…non-brand symbols	Colour	…chromatic content
System Parts	…a material part of the whole	Material	…properties of substances
Whole	… the design proposal as a single entity	Look	…quality and style
		Presence	…item introduction or removal

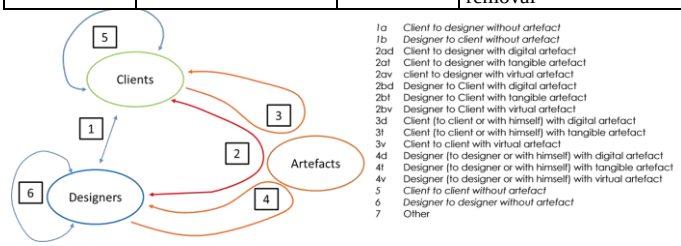


Figure 2. INTERACTION ANALYSIS FRAMEWORK AND GESTURES CODING SCHEME

The first issue was that participants were gesturing without handling or pointing any available artefact. These gestures in the air seemed to be crucial for the dialogue between participants. We decided to create a new type of artefact we called 'virtual' as the observed gesture often seemed to simulate or mimic the use or the shape of a non-available artefact. The second issue was related to the fact that several interactions may occur at the same time in parallel. We faced this problem when several participants were interacting at the same time but their attitude proved that they were taking part in different interactions (eye gaze, body orientation...). As we wanted to keep traces of every interaction with artefact occurring during the session we decided to create a marker called 'Aside'. This is not to be considered as a new category rather a marker and it does not interfere with the quantitative analysis. The category 'Other' was created for coding every interaction that did not belong to other categories. It included for instance social interaction or any gesture with artefacts that were not considered as design task related.

B. *Coding scheme for speech*

As well as for the coding scheme of Section 4.1, the analysis of speech does not aim at clarifying the cognitive processes emerging during the collaborative design session. It rather aims at capturing the contents of the dialogues among the session's participants, with reference to what characterizes the design proposal. To this purpose, the coding scheme has been developed in order to highlight the items (the kind of data an ICT platform should manage to support a co-design session) and the related features (the potential actions on items the ICT should embed for an effective interaction with SAR-based artefacts) that the participants mention. Table 1 collects the coding scheme for speech, respectively with reference to items and to their features.

Tableau 1. CODING SCHEME FOR SPEECH ANALYSIS: ITEM-BASED CONSTRUCTS AND RELATED DESCRIPTIONS (COLS 1,2); FEATURE-BASED CODING SCHEME AND RELATED DESCRIPTIONS (COLS 3,4)

Consistently with what was done for the coding scheme about gestures, the constructs of Table 1 have been defined after a preliminary observation carried out on a pilot test case in the company, whose results are not presented in this paper. Items are mutually exclusive from each other. They refer to components of the packaging which are central elements of the interaction. Features are attributes of Items. They provided indications about the characteristics of items that designers, clients or end users would like to keep as it is, in case of appreciation, or transform, in case of dislike.

V. RESULTS FROM SEPARATE ANALYSIS

A. *Results from gesture analysis*

The results shown in Figure 3 highlight that most of the interactions are supported by different types of artefacts (88%). Less than 12% of the interactions do not involve artefacts, which denote the importance of the artefacts involved in a co-design session. This supports our underlying hypothesis of the predominance of artefact-centric interactions in co-design sessions. The results also spot that clients tend to use digital artefacts (10,4%) and virtual artefacts (16,2%) to communicate with designers, both representing almost 1/3 of the interactions of the whole session. On the other hand, designers mainly express themselves using tangible artefacts (17,4%) as they mostly use the paper prints of the design alternatives as a basis for their interactions. This allow them to move more freely around the table. We can notice that interactions initialised by clients are more frequent than thoseinitialised by designers (35% Vs 26%). This shows that clients are real actors in the co-design process and are more than simple validators of design proposals. Interactions between clients appear to be also important, especially those involving the tangible artefacts (17%) used when clients discuss between themselves manipulating or pointing at a tangible artefact available on the table. We observe the same phenomenon with the designers who mostly communicate between themselves through tangible artefacts (14%). One important point that is uncovered by this study is the role of virtual artefacts. These artefacts are by

nature neither physical nor digital, however they behave as actual artefacts in the interactions between stakeholders. Around 17% of the total interaction time was involving virtual artefacts. Here virtual artefacts can be considered as cognitive artefacts (Normann, 1991) in the sense that they act as amplifier of the message to be conveyed and have a representational dimension just as physical artefacts. We outline here the imaginary dimension (Athavankar, 1999) of these artefacts that may enhance their creative or evocative power. An interesting perspective could be to study the functions of these virtual objects during co-design and the impact of SAR technology on the creation, manipulation of these virtual objects. Additionally, we noticed that clients used these artefacts to express their thoughts during communication with designers. It may also be explained by the lack of other available artefacts, which lead them to express their thoughts through some gestures within the air.

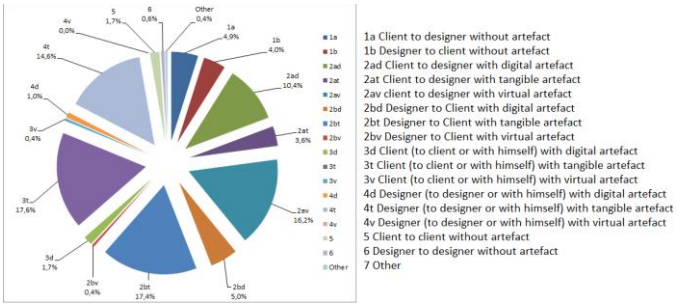


Figure 3. RESULTS OF GESTURE INTERACTIONS ANALYSIS

Another result indicates an important percentage of aside interactions; they are the interactions that occur in parallel between subgroups during the session. They count as 28,5% of the total interaction time. This indicates the necessity to handle this type of situations in the SAR environment. Gesture interactions indicate a high level of activity through artefacts of all types. However, we have no indication at this level on the contents of the interactions and especially on the purpose of the speech associated that could help us to understand if gestures we observed are linked or not to artefacts handled, pointed or drawn in the air, as instead achieved with the joint analysis described in section 6.

B. Result from speech analysis

Figure 4 collects the results of speech analysis, showing the distribution of the different coding (items and features) over a total time of interaction (TTI) corresponding to approximately 30 minutes (1784 seconds). The results of the two categories of coding are separately presented.

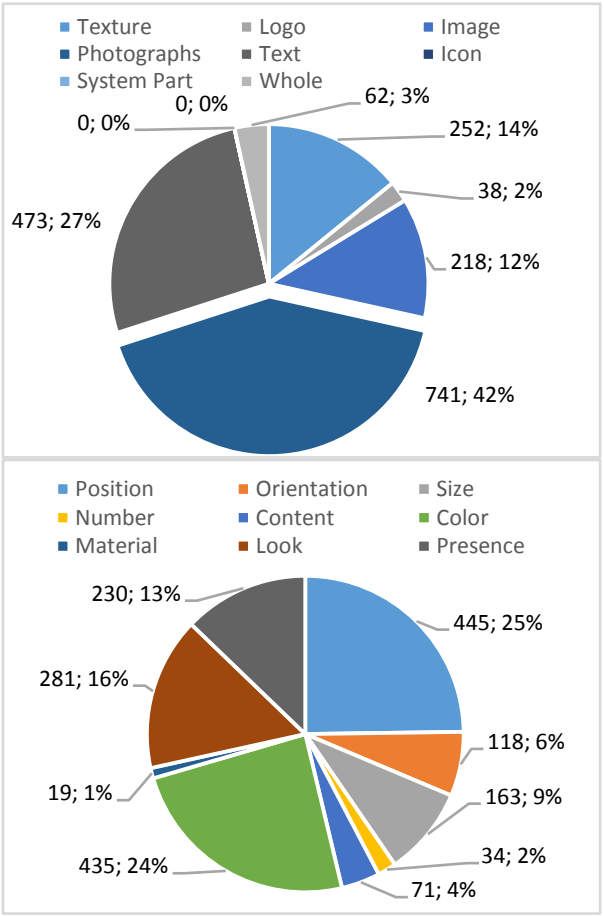


Figure 4. FIGURE 4 - SPEECH ANALYSIS - LEFT SIDE (A): ITEMS; RIGHT SIDE (B): FEATURES

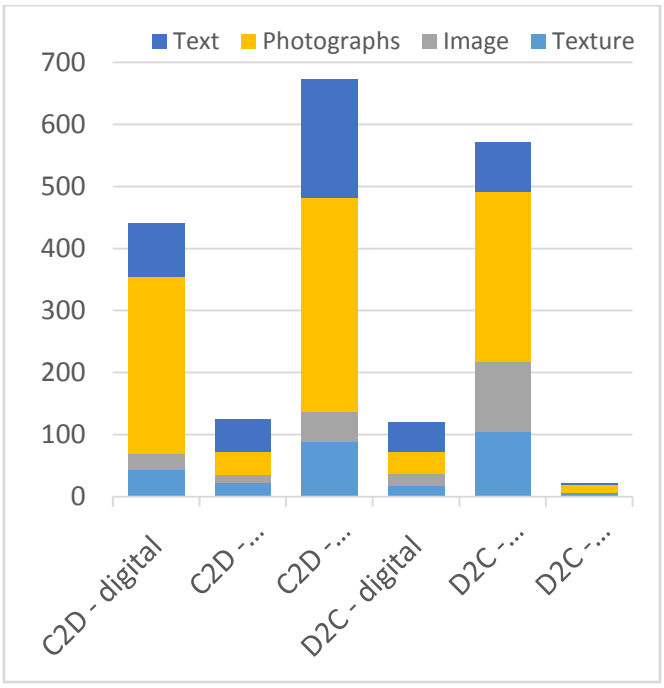
Figure 4-a shows that both Icon and System Part have not been mentioned. For Icon, these depends on the fact that the typical stamp for organic product is not in the front side of the design proposal as thecustomers directly associate the brand logo and the corporate identity to that product category. On the contrary, the absence of system parts reflects, as recalled in the introduction, that the coding scheme addresses both the purposes of package and product design and, in the former, system parts are mainly graphical contents. On the other hand, more than two thirds of the occurrences have been coded as photographs (42%TTI) and text (27% TTI). This suggests that these items are the ones that mainly captures the attention of the participants. These results, however, do not clarify at all who puts the higher interest in these topics; whether this depends on designers asking for feedbacks or on clients that want to express their opinions. A conjoint analysis can also help clarify such uncertainty. Figure 4-b, in turn, shows that

also Material and Number of items are almost negligible (3% TTI). As for Material this depends on the pure graphical evaluation of the design proposal (an end user spent a few seconds asking if the mock-up she interacted with provides a similar touching experience in reality). The scarcity of time spent talking about Number of items is more surprising, since one can expect that the number of photographs or images should be increased or decreased. To this purpose, the 3% of whole coding (Figure 4-a) suggests that the composition of the design proposal was already well balanced without requiring the introduction or the removal of more items of the same kind. However, a significant amount of "Presence" also suggests that single items on the design proposals have been suggested for addition or removal according to the discussed topics. Again, a conjoint analysis helps distinguish if this feature change depends on a feedback request from designers, on clients and end users expressing opinions about the design proposal, or both. About two thirds of the TTI (65%) have been spent discussing on Position, Colour and Look of items, which appears to be the most relevant elements for the evaluation of a design proposal for package design. This consideration, as for the previously mentioned ones, needs to be confirmed by the analysis of mutual interactions between designers and the other participants to the collaborative design session. A uniform distribution between designers and others would more likely highlight the request of opinions from designers and the related feedbacks from clients. On the contrary, an unbalanced distribution towards clients would suggest that these features are the most effective in creating appreciation or dislike during the evaluation of packaging design proposals.

VI. RESULTS FROM THE CONJOINT ANALYSIS

For processing such conjoint analysis, we adapted our respective corpus (gesture and speech) in order to synchronise the data. It has been done in two main steps: to adjust the time segmentation; in case of 'aside' interactions, to keep only the gesture interaction related to the verbal interaction occurring at the same time. The separate analysis of gestures and speech highlighted that some topics (items or features) and some gestures occur more frequently than others do. In order to check the advantages coming from the combination of the analysis described in section 5.1 and 5.2, it appears convenient to focus the attention on topics and gestures occurring more frequently, as they will lead to more robust conclusions. Figure 5-a graphically shows the frequency of interactions with digital, tangible and virtual artefacts with reference to the items (text, images, photographs and textures) verbally discussed at the time of the interaction, as designers and clients just seldom mentioned logos, icons, system parts and the whole composition of the package. Figure 5-b, in turn, shows gesture-based interactions with reference to the full set features presented in section 4.2. The graphs show Client-to-Designer interactions (C2D) and vice versa (D2C) as these interactions are the ones that more frequently occur during the recorded codesign sessions. Both graphs show that C2D interactions occur more frequently than D2C. This supports what we already discussed in section 5.1: designers have instruments to clearly describe what they are referring to, as there is a clear prevalence of interactions through tangible artefacts (17,4% of Total Time of Interaction -TTI) and an almost complete absence of interaction through virtual artefacts. On the contrary, clients usually interact through digital and virtual artefact (26,6% TTI). This shows that clients refer to something tangible, when available, and that they resort to hand gestures in order to address design proposals shown on TV screen (see Figure 1b) or shape concepts by hands presumably to reinforce what they can just verbally refer to. Entering into the detail of the conversation related to the interaction, Figure 5-a highlights that photographs played a relevant role in the entire discussion. However, beyond them, designers more frequently discuss about the graphical elements (images and texture) they are proposing through tangible artefacts (e.g., mock-ups), presumably to gather feedbacks about end users and clients' expectations.

On the other hand, clients' commentaries more frequently refer to text (yet after photographs). As clients usually refer to more detailed and contextualized items while designers are more used to abstraction, we can hypothesize that this reflects a potential mismatch in shared external representations between designers and clients, depending on their different background knowledge, which results into potential communication barriers.



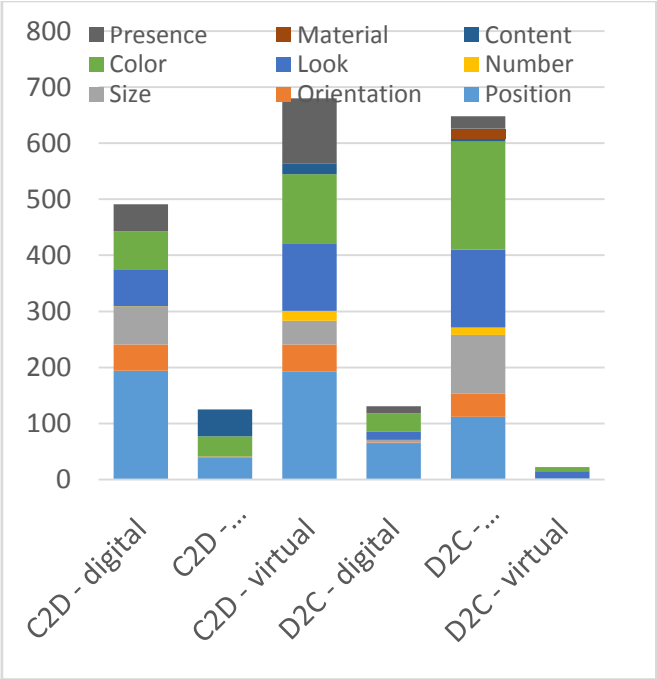


Figure 5. FIGURE 5 - COMBINED RESULTS OF GESTURES AND SPEECH; A- LEFT) ITEMS AND GESTURES (SECONDS); B-RIGHT) FEATURES AND GESTURES (SECONDS).

Furthermore, it is interesting to consider the ratios of textual items considering the different artefacts used for the interaction, which follow a different pattern with respect to the overall discussion. Designers mostly use digital artefacts to refer to textual items (39% D2C-digital; 14% D2C-tangible; 9% D2Cvirtual), while clients mostly opt for tangible artefacts (20% C2D-digital; 42% C2D-tangible; 28% C2Dvirtual). This suggests that text might require a more fine-grained information processing that needs a closer (tangible) interaction with an artefact, as it appears hard to externalize knowledge about textual items with just speech and distant gesture interactions. Figure 5-b on features and gestures joint analysis presents some expected and some surprising results. Position is the most frequently mentioned feature (whatever the interaction is), since it is paramount for the definition of the composition of the overall package. The large amount of time spent to discuss the presence of items in C2D interactions also confirms the need to discuss of the package composition. On the contrary, features that people would more easily express by hands, such as size and orientation (as touch-HCI allows to change) are not particularly frequent in the interactions with virtual artefacts (13% C2D-virtual and almost absent in D2C-virtual). Moreover, it is also surprising that features as colour and look, which one can hardly describe by hands are among the most frequent features presented in C2D virtual interactions (Colour 19% C2D-virtual; Look 18% C2D-virtual). The almost uniform distribution of these items also in interactions from clients to designers with digital artefacts (Colour 15% C2D-digital; Look 15% C2D-digital) shows that the digital artefact (and the tangible as well, for which this interaction is missing) might not be sufficiently representative to describe what the client would like to express by spoken words. The strong prevalence of C2D-virtual interactions over TTI also suggests that new communication channels (artefacts), and related enabling technologies, are required to facilitate knowledge externalization processes from Clients to Designers.

VII. CONCLUSION

The paper proposes the joint analysis of gestures and speech to elicit the behaviours of designers and clients in a collaborative design session. Compared with gesture analysis and design protocol analysis accomplished separately, as typically proposed in literature, the joint analysis allows investigating more in detail the role of gestures through and with artefacts, and their impact on the co-design process. We applied the joint analysis to a real case study dedicated to the packaging of consumer goods, involving designers from the Italian design company Artefice, their clients Alce Nero (producers of organic food consumer products) and exemplary end-users, the latter two referred as Clients. The analysis highlighted the differences between the participants both in terms of the object of the design discourse (more or less abstract) and the communication means (with digital or tangible artefacts). The case study also revealed a significant portion of the interactions from the Clients to the Designers went through gestures not referring to any digital or tangible artefact, but rather to gestures in the air that seemed to mimic some features of a non-available artefact. The study conducted so far does not allow claiming whether this is due to a lack of appropriate communication means, or to a lack of knowledge and representation skills. Those options shall be investigated in the follow-up of this research activity, together with the general role played by those virtual artefacts in co-design sessions. Beyond demonstrating the advantages of such joint analysis, the study also confirmed the potentially relevant role of an ICT platform for supporting the interaction in a co-design session, since digital artefacts occurred quite frequently both in Designer-to-Clients and Clients-to-Designers interactions. This is aligned with the expectations of the SPARK project, within which this study is conducted. The joint analysis seems to be promising also as a method to evaluate the impact of the new SAR-based technology under development on the performance of co-design sessions.

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