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PLAYING CARDS: SPATIAL ARRANGEMENTS FOR OBSERVATIONAL LEARNING

This paper looks at how players of a card game create *spatial arrangements* of playing cards, and the cognitive and communicative effects of such arrangements. The data is an episode of two 8-year old children and a teacher playing the combinatorial card game Set, in the setting of the leisure-time center. The paper explores and explains how the visual resources of the game are used for externalizing information in terms of distributed cognition and epistemic actions. The paper also examines how other participants attend to the visual arrangements and self-directed talk of the active player. The argument is that externalizing information may be a strategy for reducing cognitive load for the individual problem-solver, but it is also a communicative behaviour affecting other participants and causing them to engage with the problem and the problem-solver. Seeing and hearing players who have succeeded in finding a set provide observers with rich learning opportunities, and increases their motivation to play the game. From the point of view of learning design, the consequence of this is that bystanders merit to be considered as the potential learners of a pedagogical game as much as the players themselves.

Key words: Visual artifacts, spatial arrangements, self-directed speech, observational learning, game design

Playing cards: spatial arrangements for players and observers

Players of a card game arrange and rearrange cards in different spatial formations: in stacks, hands or spread out on the table. The sequence of visual card arrangements reflects – or constitutes – the progression of the game. However, visual arrangements of playing cards have other functions

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as well: they form spatial structures framing players' actions, and they serve as semiotic resources used together with speech and gesture in the players' multimodal communications. Playing cards, and the visual patterns they build, are persistent in comparison with speech. They remain on the scene (Streeck, 2011) available to all participants.

In this paper I will look at how players of the game Set go about searching for cards, and how the visual resources of the game are used for epistemic actions, with the aim to facilitate search. However, as information is externalized, through card arrangements, pointing or self-directed speech, the information becomes accessible also to bystanders. The second theme of the paper is how other players make use of visualizations and self-directed talk of the active player. The argument is that externalizing information may be a strategy for reducing cognitive load for the individual problem-solver, but it is also a communicative behaviour affecting other participants and causing them to engage with the problem and the problem-solver.

The setting: the leisure-time center

The episode described and analysed here was recorded at a leisure-time center (LTC) in southern Sweden. Most Swedish children age 6-9 attend a leisure-time center after the end of the school day. At the LTC, children choose what activity they want to engage with. A consequence of this is that children at the LTC spend a lot of time roaming around, looking at what other children and adults are doing.

Playing games is one of the staple activites of the LTC. There are often large collections of games that children may choose from. New games are introduced by teachers playing with a small group of children, offering the other children the opportunity to observe the game before deciding to join in. Many of the games require adult participation: reading and interpreting rules demand literacy skills beyond the childrens' abilities. Some games become adopted by a group of children and are played extensively over a period of time. This often entails changing the rules, making them easier at the start in order to match players' skills. The children I met at the LTC were in general clear about the difference between the rules used among themselves while playing, and the "real", or "written" rules.

The study

The video sequence analysed here was part of a study on observational learning, mathematics, motivation and design. The study looked at how the design of a game builds opportunities for observational learning, and how these in turn contribute to bystanders' motivation to engage with the game.

The game played by participants was Set (see www.setgame.com), a card game building on combinatorics and visual search. Even for an adult player

the game is cognitively demanding, but it is also rewarding as players enjoy (and express) the sudden shift from not seeing to seeing a matching set among the displayed cards.

Playing Set consists in finding combinations of three cards that fulfil the criteria of being "all similar or all different". The deck consists of 81 cards, each with a different combination of color, shape, number and fill. The version used in this study was different from the commercial game, using symbols and colors that have well-known and unequivocal names in Swedish.

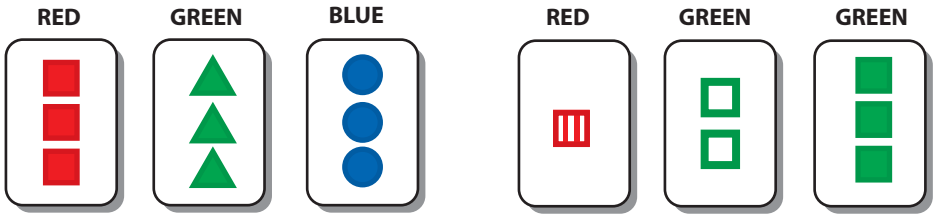


Figure 1. In order to form a set, the three cards need to be "all similar or all different" for each of four criteria: number, fill, shape and color.

In the original rules, Set is played without turn-taking: all players search at the same time for matching sets from 12 cards lying face up on a table. Players are only allowed to move cards around after announcing a set, in order to show the other players. The players at the LTC modified these rules in order to make the game easier to play, as I will discuss later in this paper.

Obtaining consent

The study was conducted in the main space of a LTC, and children came and went as they wanted. One class and their teacher were involved in the study, but many other children were present in the LTC. The children whose parents had signed the Informed Consent form distributed by the teacher were not always those who wanted to joint the game. In order to respect the educational setting, all children wishing to participate were allowed to do so. The camera had been positioned in order to film only those children whose parents had given their written consent. As a consequence, many of the gaming episodes were not recorded, and many of the recordings had to be deleted as children without permission to participate in the study had joined the game.

Theory: externalizing information

Within the field of distributed cognition, many researchers have studied the cognitive effects of externalizing information. Zhang and Norman (1994)

compared different versions of the Tower of Hanoi game, and concluded that visualizations that build upon subjects' prior knowledge reduce the investment in memorizing rules, and improve performance in a mathematical task.

Kirsh and Maglio (1994) coined the term epistemic actions with reference to how Tetris player rotate puzzle pieces on the screen instead of performing mental rotations while finding out where to place the piece. Rotating the visible puzzle pieces results in a transformation of the task, which Kirsh (2010) describes as follows:

> Reorganizing pieces in physical space makes it possible to examine relations that before were distant or visually complex (e.g., rotations and joints). By re-assembling the pieces, the decision is simply a matter of determining whether the pieces fit perfectly together. […] Interaction has thus converted the world from a place where internal computation was required to solve the problem to one where the relevant property can be perceived or physically discovered. (Kirsh, 2010, p. 446)

One aspect of externalization of information is thus to reduce cognitive load, and in the examples above, reducing the effort needed for creating and modifying mental visualizations. Another way to make use of visual artifacts, or visual arrangements of artifacts, is to use one's hands as a dynamic extra layer on top of the artifacts. Kirsh (1995) shows how problem-solvers use their hands together with visible artifacts, forming multimodal constructions of visual arrangements of artifacts, with hands either marking connections between objects or special points of interest (Kirsh, 1995). Hutchins (2008) presents a series of examples how hands are used for conferring qualities of movement to static images.

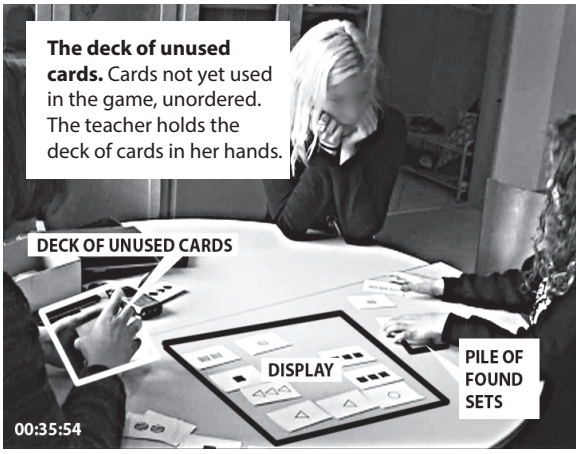
Externalization need not be visual. An example of this is self-directed speech, which is common in children, but in most cases becomes internalized around the age of 9. When a person is confronted with unfamiliar or difficult tasks, audible self-directed speech may re-emerge, also in adults (John-Steiner, 1992). Self-directed speech is shown to have a positive effect on visual search tasks, leading Lupyan and Swingley (2011, p. 15-16) to the conclusion that "language not only is a communicative tool, but modulates ongoing cognitive and perceptual processes in the language user, thus affecting performance on nonlinguistic tasks."

Similarly to information externalization using visual artifacts, self-directed speech thus has a facilitating effect for the person producing the utterance. However, externalizing actions make the information available to bystanders as well, or in the case discussed here, to players waiting for their turn. The question is how externalized information, through visual arrangements or self-directed speech, informs the actions of other participants. According to Steinbach-Koehler and Thorne (2011, p. 87),

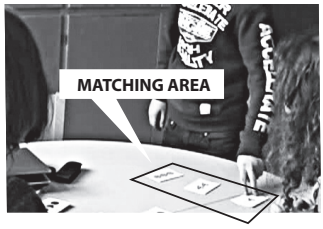
self-directed speech is by default intrapersonal and interpersonal at the same time: "opening up slots for group problem solving and interactional achievement".

Spatial arrangements "of playing cards"

The game Set offers an interesting platform to explore how external representations, epistemic actions, and self-directed speech scaffold visual search. Following the original rules, the game involves three types of spatial arrangements of playing cards (see figure 2). The *deck of unused cards*, shrinking as the game progresses, was generally held by the teacher or an appointed helper among the playing children. The *display* with 12-15 cards, is placed in the middle so all players can see it and reach the cards. *Piles of found sets* are in front of those players who have succeeded in finding sets.



The display: 12 or 15 cards arranged in a rectangle, among which players search for sets.



The matching area: in some cases, players establish a matching area in front of themselves, and move cards there for matching them.

Piles of found sets. One pile per player, or team of players. Players often refer to their previously found sets, for explaining the game to others (as above) or as an object for contemplation.

Figure 2. Spatial arrangements of playing cards in a game of Set.

As mentioned earlier, the game was played with a few modifications to the rules. Players took turns searching for sets, and the number of cards to search from was increased from 12 to 15. The active player was allowed to move cards around while searching. This led to a new structure on the table: a matching area to which candidate cards are moved, located right in front of the active player or, in case of two collaborating players, somewhere between them. The exact placement of both the display and the matching areas tended to shift throughout a game, reflecting changes in the game. For example, if the matching area of two collaborating players starts to move to one side, this is an early sign of the collaboration coming to an end.

Figure 3. Ella and Gnar start by searching for sets together. In the still image to the left, the matching area has moved over to Gnar's side of the table. To the right: Soon after, collaboration is over: the two players compete to be the first one to get hold of a set.

Ivan and Leo

This paper builds upon a short filmed episode of two children playing Set together with a teacher. Leo and Ivan are classmates, both 8 years old. This is their first encounter with the game. The clip begins about 20 minutes after the start of the session. After 30 minutes, Ivan leaves for home. Leo continues to explore the game together with the teacher. Other children come and go as the game is played.

Leo is the active player as the clip begins. He marks cards with his hands and moves them around, while engaging in self-directed speech. Cards are moved to a matching area directly in front of him. The teacher follows his actions, and offers guidance from time to time.

Analysis

The visual scene is delimited by the circular table, and by players' visible bodies. Participants create a system of spatial and orientational relations allowing them access to each other's actions (Kendon, 1992, p.328). The table is too wide for players to sit on either side of it, and even as Ivan and Leo sit beside each other they have to then stand in order to get an overview of the displayed cards and reach out for them. In the short sequence illustrated above, Leo undertakes a number of actions in order to facilitate his search:

(i) Adapting body and the visual field: rising to a standing position, leaning over the display in order to avoid perspectival distortion (6).

(ii) Establishing a matching area in order to minimize irrelevant visual information (2).

1. *Ivan: ((Smiles at Leo while tapping a card with his index))
2. Leo: It is a FULL that is a TWO ((taps on his cards with both hands at FULL and TWO))
3. Ivan: A full one… ((leans backwards, gaze to Leo))
4. *Leo: ...that is a TWO ((taps on his cards with both hands at TWO))
5. *Ivan: A full one…((raises to his feet, scans the display))
6. Leo: There isn't any.

*Note: Lines preceded by * correspond to the pictures to the left.*

Figure 4. Illustration of the example being analysed. From left to right: Teacher, Ivan and Leo.

(iii) Using hands to mark relevant cards (1) or as an indication of the connection between a verbal utterance and the cards (4).

(iv) Self-directed speech: verbalizing what to attend to in different phases of the search (2,3,4).

Ivan, in turn, uses Leo's utterances and gestures for following and engaging in the search:

(i) Looking at Leo' s hands as an indication of which cards are relevant (4).

(ii) Proposing a card (1), elaborating on the cues (pointing and verbal utterances) provided by Leo.

(iii) Elaborates on Leo's utterance in line 4 by repeating the verbal description (3,5) and operationalizing it in a new round of searching for a suitable card.

There are three general aspects of the visual structure of the game played by the children that deserve further elaboration: (i) frontality, (ii) visual field optimization, and (iii) self-directed speech engagement.

Frontality. The spatial arrangements of playing cards reflect the relationships between players. There is a strong tendency for players to place visual arrangements in front of themselves, aligned with their body center. In this example, the display is in the middle between Ivan and Leo, but Leo establishes his matching area at his end of the table, making it clear that he engages in individual search.

Optimizing the visual field. Players continuously re-arrange their bodies in order to optimize visual access to the game, and in order to reach the cards. In moments of increasing tension, such as immediately before engaging in a new activity, players tend to stand up. This serves at least two ends: expanding the reach of their arms, and achieving a better view of the cards. As a player stands up and leans in over the over the displayed cards, the relevant visual information is allowed to fill out her visual field, minimizing perspectival distortion.

Guiding attention through self-directed speech: Players of Set have to match four properties across the three cards of a potential set. Most new players use self-directed speech to guide themselves through the process of checking for color, number, shape and fill. There are four properties of cards that need to be matched. Many beginning players use self-directed speech for directing their attention to one property at a time: shape, number and fill. Leo, however, uses another strategy: verbalizing the properties of the "missing card" that would form a set with the two cards in his matching area.

Both teacher and Ivan acts on Leo's talk and gestures by engaging in the search as well and offering advice. In this they treat Leos' externalization as as if they were a shared resource, intended for all persons at the table:

> participants can treat others' self-directed talk as a display of task- and group-relevant problem-solving procedures that makes visible the foci of attention, such as cognitive processes and linguistic and performance-based problems, and thus becomes a resource for maintaining intersubjectivity. (Steinbach-Koehler and Thorne, 2011, p. 67)

However, Leo is more attentive to the teacher, and he resists to let Ivan participate in the search by turning down Ivan's proposal. The placement of Leo's matching area also indicates that Leo is not inviting Ivan to collaborate.

The attentional focus of Ivan moves between Leo, the visible card arrangements on the table, and the teacher. He attends to the actions, talk and gesture of the other participants, and to their attentional focus. Tying

back to the main argument of this paper, the entire scene provides Ivan with rich opportunities for observational learning. It combines the visible events of the game with the social information about other participants' attitudes and actions to those events.

Discussion

The proposal of this paper is to approach externalization of information during problem-solving as a social and communicative action. At this point, I will widen the discussion from a group of players, and also include bystanders: those who stop by for a while to observe the game and what the players are up to,

Adapting games and rules to the group of players and their level of skills is a common behavior at the LTC. When a game is new, it is often simplified, and as players' skills increases, new challenges are introduced in order to keep a suitable level of difficulty. The children at the LTC were aware of this, and they had no problem explaining the difference between the "printed" rules and the local adaptations. In the line of argument of this paper, two of the adaptations were especially productive in terms of observational learning: re-arranging cards and turn-taking. The visible arrangements of cards made the problem available to other participants, supporting their engagement with the problem. Turn-taking created opportunities for the player waiting for his turn to engage with and help the active player. Furthermore, the repetitive turn-taking structure made it easy for new players and casual observers to identify the different phases of a turn, and figure who would act next.

In short, these changes made the game easier: first, by providing feedback to the individual players while playing, and second, by increasing the opportunities for learning through observation for other children in the vicinity. The video recordings from the LTC indicate that players engaging in the play of others learned the game faster compared to those zooming out while waiting for their turn.

Three kinds of epistemic actions can be found in the clip analysed here: visual re-arrangements of cards, marking cards with hands, and self-directed speech. Self-directed speech was also used as a visualizing tool, helping the player to create a mental image of the card he was looking for. There is no doubt these actions facilitate the task for the individual problem-solver. However, the effect on bystanders, leading them to engage with the problem and the problem-solver, adds leverage to the benefits of externalizating information beyond that of reducing cognitive load.

Finally, observing how other children play is also important for motivation. Most new players started by watching other children play. Seeing and hearing players who have succeeded in finding a set provide observers

with rich learning opportunities, and increase their motivation to play the game. Especially when somebody found a set or was getting close to finding one, bystanders' attention to the game increased. In this sense, the accessibility of gameplay to bystanders – both the visual information and the emotional expressions – added to the motivation of potential players. Applying this to game design, the implication is that observers are as much the target group for pedagogical games as the players.

The next step in this line of research would be to look at the social aspects of externalization in different institutional environments. In the LTC children are allowed to roam around and look over the shoulder of other children, a behavior that is less accepted in the classroom where children are expected to focus on their own task. Another issue that would be interesting to explore further is how the relation between problem-solver and bystander influences on the response of the bystander. However, already with the material presented here, it is clear that designers of learning games should consider the context of observing other players as a learning opportunity at par with the context of playing oneself.

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