'CircleUp': Artifact Design for Stimulating Participation in Social Group Play Through Joined Sensemaking with Accessible Signifiers

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ABSTRACT

This paper describes the design process of an interactive artefact intended to mediate in the joined sensemaking between children engaged in social group play and children that intend to join this group play. By using the research-through-design method the theories of participatory sensemaking, affordances and external representations are explored to go through various iteration cycles. After the focus of the artefact was determined, a preliminary prototype that required cooperation was developed. After performing observations and reviewing relevant literature and theories, joining was reconceptualised as a process that encompasses gradual steps, rather than an instant moment. In line with these findings, a new concept was developed and presented. The concept was adapted based on feedback and additional literature. The final design, named 'CircleUp', contributes to the process steps of joining a group, creating an easy opportunity for children to join in group play. The artifact includes accessible signifiers which externally represent the creation of groups, which happens through joined sensemaking as the children need to concurrently interact with the artifact to form teams. This provides children that desire to join the agency to do so. The children then start the group play together. The final concept was tested using the Wizard-of-Ozz technique, where a combination of regular user testing and improvisation was performed. Seeing the artifact in use gave a clear view on the connection to the theories of affordances, external representation, and participatory sensemaking. The test showed the role of the artefact in the joined sensemaking of the participants, and the embodied nature of the design, as participants were using their bodies together to create meaning with the artifact. These insights revealed strengths and potential shortcomings in the design of the artefact. Further research into the steps of joining and the effects of the artifact on this process is required.

Keywords: Participatory Sensemaking, Joined Sensemaking, Affordances, External Representation, Group Play, Artefact Design.

INTRODUCTION

Participation in social group play is one of the many observations one will make when looking at primary schoolers during break time. While playing outside on the playground, the 6 to 12-year-olds play together in different group sizes, which can vary from two children to the whole class. One may also observe that there is one child wandering on its own. At first, it may look like the child wants to play in isolation. However, by further observation the child wanders near groups of children which are in ongoing participatory play. The child looks at the group from a distance and tries to move towards them. Halfway on their route the child decides otherwise and remains in its position, at a distance from the group. The child may sense varies feelings and emotions. They decide that they prefer to play alone, or they would prefer to join in group play, but find it difficult to join the already established group, maybe out of fear of not being accepted.

The scenario above sketches the difficulties which may arise during social group play. It is meant to show that joining social group play can be difficult for some children, meaning they end up excluded and feel left out of the group. This difficulty may arise because the phenomenon called joining, becoming involved in an activity with other people (Join in (Something), 2025), may not be intuitive for all children. For most children, this phenomenon is intuitive; they join ongoing group play without consciously thinking about it. However, for other children it may not be; they see the phenomenon as a problem they are not able to solve. It might help them to have a way in which they can gradually join the ongoing play.

To aid these children, this paper investigates how participatory sensemaking, creating a common understanding together with others (De Jaegher & Di Paolo, 2007), can positively influence social play between children engaged in group play and children who intend to join this play. This will hopefully support the children, for which joining group play is not intuitive, to join in ongoing group play by empowering them and creating more agency for them. The result of this research will be in the form of an artifact which will be established using the research-through-design method. This means that design, in the form of creating prototypes, is used as a method for generating new knowledge (Research Through Design, n.d.).

To give form to an artefact intended to support children in joining ongoing group play, the theories of affordances, which explains how an object speaks to the user in terms of actions which can be performed with it (Gibson, 1979; Norman, 1988), and external representation, which explains that tangible or digital artifacts can be used to represent an internal thought (Jaasma et. al., 2017), are explored. These theories will provide insights during the development of the artifact to make sure that the participatory sensemaking between the different children will be positively influenced.

DESIGN CHALLENGE AND RESEARCH QUESTION

The central design challenge discussed in this paper is formulated as: 'How can an interactive artefact be designed to mediate the joined sensemaking of children in group play to create agency to motivate and empower children to join ongoing group play?' Two research questions relating to the theory of participatory sensemaking are formulated:

- What design forms can be employed to allow the designed artefact to positively impact participatory sensemaking?
- What role can artefacts play in the theory of participatory sensemaking?

The paper will first describe the relevant theories of Participatory Sensemaking, Affordances and External Representation. This section will be followed by a brief review of relevant literature and a description of the methods employed to design the artefact. The different iterations of the designed artefact are then explained and illustrated. The designed artefact and its connection to the discussed theories and literature are reflected upon in the discussion. The paper concludes with recommendations on future research and a concluding summary.

THEORY

Participatory Sensemaking

Sensemaking is the process in which individuals create understanding of their environment through interactions. (De Jaegher & Di Paolo, 2007) This is closely related to sensorimotor couplings, the ongoing loop of sensing and acting. What we perceive influences our actions and also the other way around, this happens as automatically as a habit and results in our grip on the world (Van Dijk & Hummels, 2015). Participatory sensemaking is about creating understanding together with others, a co-creation through joined sensemaking. This helps people connect with each other and creates social couplings, where the coupling is between at least two autonomous agents (De Jaegher & Di Paolo, 2007; Van Dijk, 2023).

Connecting this topic to objects brings it to another dimension. In early research, objects were seen mainly for external representation of mental processes in which the objects played a passive role (Van Dijk & Hummels, 2015). But as described by Van Dijk (2023) they can also be seen as playing an active role in sensemaking and in joined sensemaking. Objects can function as attunement anchors around which participation couplings are formed (Van Dijk, 2023). Participatory couplings are social couplings

where the agents create shared meaning and thus participate in joined sensemaking (De Jaegher & Di Paolo, 2007). The objects they interact with create a shared focus point and support mutual understanding as they mediate the ways of communication (Van Dijk, 2023). Children engaging with an interactive design is a form of joined sensemaking where participatory couplings are made. Through the design it will be researched how it influences interactions among children.

Affordances

James Gibson introduced the concept of affordances of an environment as what it offers or provides to the perceiver. These affordances are relative to the perceiver and therefore unique to them (Gibson, 1979). In products, affordances refer to the relationship between the properties of the object and the abilities of the perceiver (Norman, 1988). While the dependency on the perceiver prohibits affordances from being designed directly, they can be influenced through design. Unlike its foundational concepts, the presence of affordances is not influenced by the needs of the observer (Gibson,1979). These needs may influence the salience of affordances, or whether they are acted upon by the perceiver, but it is the interplay between the properties of the object and the observer's abilities that determines the presence of affordances (Gaver, 1996; Norman, 1988).

According to Norman (1988), perceived affordances provide strong clues about how to use the object to the observer which is critical in design. Don Norman later introduced the concept of signifiers to refer to this signalling component of affordances. He explained that affordances determine what actions are possible, while signifiers signal where the actions should be performed (Norman, 2013). The inclusion of recognisable signifiers can aid the perceiver in noticing the affordances of the artefact that the designers intended to be salient. The affordances of the artefact constrain or enable certain actions and interactions, thus influencing the social behaviour of the perceivers (Gaver, 1996). This perspective sees affordances as a tool for the designer, to communicate the desired actions to the users. Alternatively, the designer can consider the natural affordances of an action as perceived by the involved agents and adapt the design to align with and strengthen these. This perspective positions the making of meaning on the side of the users, rather than the designer.

External Representations

External representations are means (e.g. tangible or digital artifacts) which represent an internal thought (Jaasma et. al., 2017). The most mentioned benefit of using external representations is found in the fact that they save internal memory and make computation easier, because the user can do the thinking process outside of their head (Kirsch, 2010). As found in a study by Jaasma et. al. (2017) external representation can be used to create a "scaffold" for participatory sensemaking as it helps to store, process and represent information and share thoughts with others. However, the representation should be easy and fast to use to benefit the fast thought processes in one's mind (Kirsch, 2010). Otherwise, the representation will not function as a tool, but more as a barrier to participatory sensemaking.

To create a "good" external representation the theory of natural mapping, as explored by Norman (2002) can be exploited. Norman (2002) explains that natural mapping, when applied in the right way, leads to less errors when using an object. Therefore, it should be obvious for the user what the relationship between the controls and the object to control entails. For example, by making them the same colour. Norman (2002) mentions one difficulty with the current use of the natural mapping theory. Currently, there is a lack of accessible signifiers on the controls, hence there is a lack of discoverability. To solve this problem, designs should have clear indicators to show the user where the controls are located. This can be tied back to the theory of affordances, because there, signifiers play an important role as well.

RELATED WORK

Related work in the domain of social play investigated how artifacts can aid children in the process of participatory sensemaking. Scheepmaker et. al. (2018) and Morris et. al. (2025) found that children have aid by having clear guidelines. Scheepmaker et. al. (2018) explains that guidelines can help children to create a common understanding according to certain subjects. This aids children with

different abilities, perspectives and roles to play together in a group. They argue that the artifact should be flexible to prevent creating a barrier for the children. This means that the artifact should not state rules but provides a structure which children can use to create their own rules together as a group. When this balance is found, social play becomes inclusive for children with different characters and abilities.

These findings are confirmed by Morris et. al. (2025) who also found that children can use artifacts to create a common language of play. They create shared play rules, make divergent play modes visible and facilitate social play initiation. The children used the artifact to make requests for social play more explicit, and to invite themselves into other's social play sessions without having received an explicit invitation. Interestingly, the researchers observed that the children gave another meaning to the artifact than the researchers had intended when designing, in this case the colours of bracelets were given different attributes than intended. This underlines again that children should not be restricted in their play behaviour. Giving guidelines is appreciated, but creating barriers should be avoided.

In another study, Currin (2022) found that artifacts can help children to empower them and give them more agency. This paper, especially focused on shy children, investigated if and how artifacts can aid children to join social group play with others. She found that children need to feel empowered and need to have a feeling of agency to feel motivated to participate in social play. She developed an artifact (a system consisting of e-book stories, a play-planning app and a tangible voice agent) to investigate how it can aid children in creating a higher feeling of empowerment and agency. Currin (2022) found that these values are increased when children get the choice to decide for themselves if, when and how they want to participate in group play. Next to this, (shy) children should have the option to non-verbally communicate to others that they do (not) want to participate in group play.

The related work discussed in this section has a couple of shortcomings. Most studies found in this domain focus on neurodiverse children. There are few studies focusing on children without any "conditions". Morris et. al. (2024) is one of the few who focus on social play between children with and without diagnosis. In their research, they found that children with autism use more physical action instead of verbal communication, they stand closer to others to substantiate social play, and they dissolve from ongoing social play by walking away. These differences show that the works discussed might not always be relevant for all children, which is important to take into account.

Additionally, previous studies do not specifically investigate joining group play. Their focus in on social play when children have already joined a group. By skipping this step of joining, an interesting possible research domain is not explored. A theory which could be adapted to fit in such research is the honeypot effect (Müller et. al., 2012). The honeypot effect explains four phases of getting involved into an action: 1.) observing the interaction from a distance, 2.) approaching to take a closer look at the interaction, 3.) actively interacting, and 4.) moving on and leaving the interaction. Müller et. al. (2012) recommends this effect to be used to design more attractive public display application. However, this theory could also be used to explain the different steps of joining as being four different phases. Designing an artifact which employs this theory can aid in improving the process of joining group play.

The theory of the honeypot effect (Müller et. al., 2012) can be used to fill the current gap of knowledge on the joining process in social group play. By designing an artifact which makes it possible for the child to go through these four phases, joining in social group play could be improved. The investigations of other researchers can be used to design the artifact to be more intuitive and attractive for children. The artifact should provide children with guidelines without creating barriers, as according to Scheepmaker et. al. (2018) and Morris et. al. (2025). Next to this, the artifact should create empowerment and agency, as according to Currin (2022).

METHODS

The focus of the artefact, to aid children in joining ongoing group play, was first determined. A preliminary prototype was developed during a tinkering session. This prototype (Figure 1) stimulated group play through designed obstacles that require cooperation to overcome. Following this, the theoretical focus of the artefact was determined. These theories not only inform the design of the artefact but are used to investigate the theories using the research-through-design method. The decision of what theories to focus on was informed by observations of playing children and discussions regarding the

relevant theory. During this process joining was reframed as a gradual process that encompasses multiple steps, rather than a singular moment. This reframing highlighted a problem with the preliminary prototype. An artefact that includes obstacles that require cooperation can provoke a 'singular' joining moment that can stress children and has limited effect once the required number of players is satiated. Based on the findings in relevant literature, the concept behind the prototype was further determined to be too restrictive (Scheepmaker et al., 2018; Morris et al., 2025). The preliminary prototype was therefore abandoned and new concept directions, informed by the observations and research, were discussed. These concepts consider the process of participatory sensemaking and aim to include clear signifiers and external representation. From the discussion of possible concepts, a new concept was developed that allowed children to gradually join the ongoing group play. A low fidelity prototype was produced and presented with a brief demonstration (Figure 2). The feedback received following the presentation and submission of a draft report aided in the refinement of the concept. A prototype of the improved concept was developed (Figure 3) and tested using the Wizard-of-Ozz technique (Figure 4). The observations and feedback of this session served as input for the discussion.

THE DESIGN

The first prototype, named 'RollTogether' was developed during a tinkering session (Figure 1). Using a broad selection of different materials, a low fidelity marble track was developed that required cooperation to be completed. Following a reframing of the term 'joining', the design focus changed from an artefact intended to stimulate cooperation through designed obstacles, to one that allowed children to gradually join ongoing group play by extending the process of joining.

The second design, named 'CircleUp', features an array of tiles with a control board (Figure 2). The design is intended to support children in joining group play in between rounds. When a game has ended, the children who want to participate in the next game (those engaged in the group play and those who want to join) stand on a tile. Each tile that is inhabited by a child will light up. The control board features external representations of these tiles. The system then 'locks-in' the number of players based on the number of activated tiles, and a corresponding number of 'tiles' will light up on the control board. The children then discuss what kind of team division they prefer, after which the child closest to the control board can manually move the desired number of players to the four team positions on the control board (indicated with different colours), by dragging the highlighted tiles into place. The tiles that the children are standing on will change colour based on the division selected on the control board, to determine the teams. This selection will be random. The children can leave the tiles and engage in the group play. After the game, they can return to the tiles. The children who want to stop playing can leave, those who want to continue inhabit the tiles, and those looking to join the group can join them on the tiles.

The refinement of the 'CircleUp' saw the removal of the control board. In the final iteration of this concept, roughly 30 tiles are placed in a circle. Four tiles have a coloured circle on the tile (red, blue, green and yellow), the rest feature a white circle (due to resource constraints the prototype features only eight tiles, with two coloured and six white circles, four of which are outfitted with LED's to be 'working') (Figure 3, 4). When a game round has ended, the children approach the artefact to make new teams. Children who intend to join the group play can observe and approach the artefact when they are ready to join the game. The children that want to play step on a tile, which will activate it and cause it to light up. The tiles with a coloured circle are used to make teams; when the child standing on a tile with a coloured circle stamps, the lights in nearest activated tile (that does not belong to a team yet) will change from white to the colour of the circle (red, blue, green or yellow). This process will continue until all activated tiles belong to a colour. This action determines the number of players per team, not the team division itself, as the system will subsequently randomly redistribute the colours based on the set team division. This is done in an effort to prevent children from being excluded from teams, the threat of which could hinder a child's willingness to join. If the children are not pleased with the teams, they can jump on their tile which will then start to blink. If the tiles of children from opposing teams are blinking, they will switch teams. This process can continue until the children have figured out a fair distribution that everyone is happy with. If more than half of the tiles would be blinking, the system redistributes the colours of all tiles again. This mechanism is intended to allow children to work together to form fair groups by adjusting a distribution that includes all children that want to play.

Figure 1: Preliminary prototype developed during a tinkering session, named ‘RollTogether’

Figure 2: Low fidelity prototype of the first version of ‘CircleUp’ with two tiles highlighted

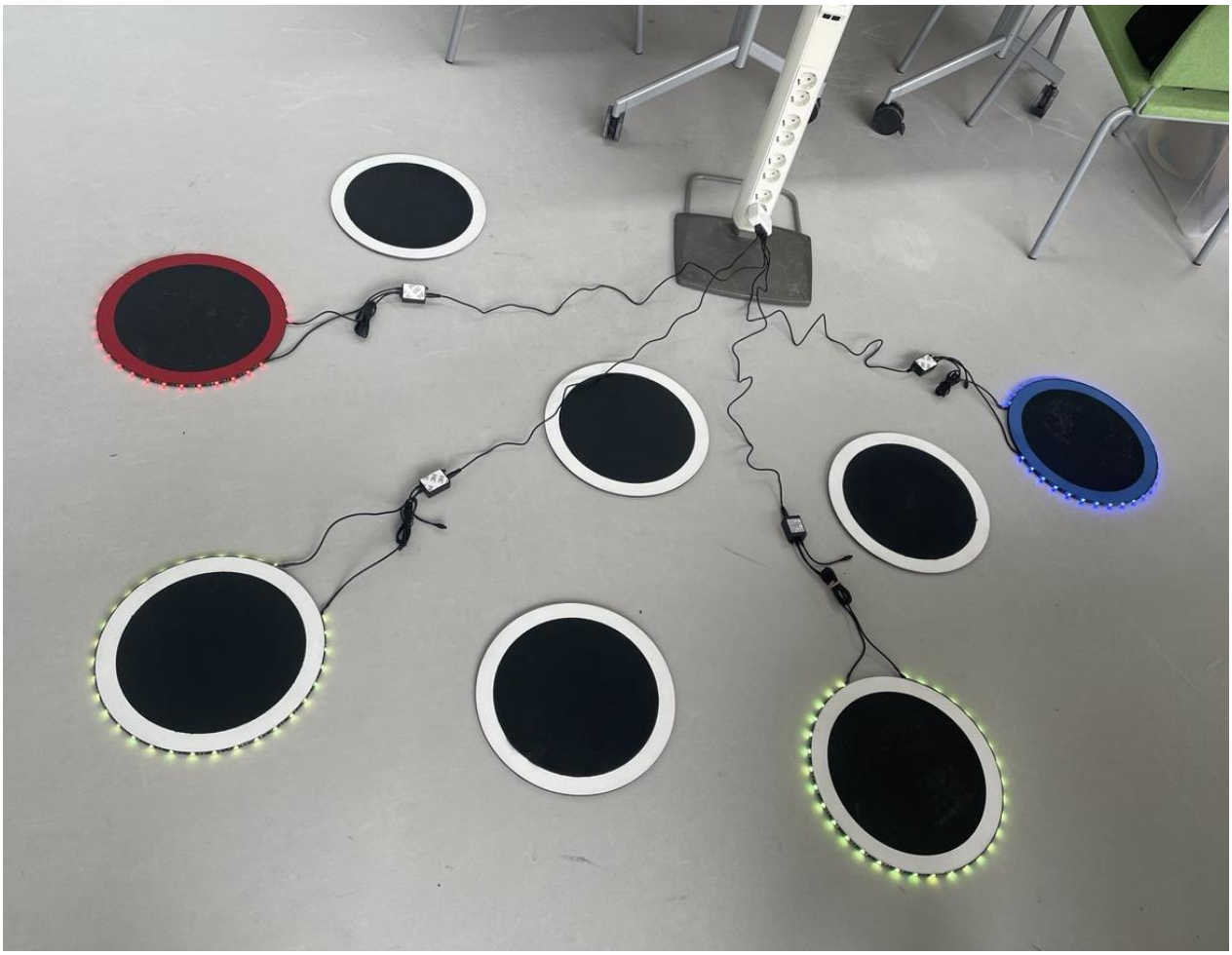

Figure 3: Prototype final version ‘CircleUp’ with eight tiles, four of which are outfitted with LED’s

Figure 4: Wizard-of-Ozz prototype testing with four participants

DISCUSSION

Reflecting on the design process, while attempting to use the embodied interaction theories in the design of an artefact, forced the design team to become more familiar with them. This asked for an understanding of the fact that affordances are always present and can be made more salient using signifiers. Also, participatory sensemaking is not something which can be created, but influenced, as it is always happening. Next to this, external representation can take more abstract forms; since the control board was taken out of the design, the external representation is more about the tiles themselves and the lights which illustrate how the teams are divided. These theories were all implemented into the design, which in its final iteration moved to a more embodied system, where the children use their bodies to determine the teams, and which considers the physical movements a child, that is looking to join, likely makes (observe, approach, join the group).

The artefact was tested using the Wizard-of-Ozz technique over three rounds. During the first round the intended function of the design was explained to participants. During the two subsequent rounds only the context and purpose were explained. Participants found it intuitive to step onto the stones, meaning that the signifiers (circles on the tiles) were able to make the desired affordances (to step on) of the system sufficiently salient. The light on the side turning on when the participants stepped onto the tiles brought excitement, but without an explanation of the design, the ‘meaning’ behind the changing of the colours was not always understood. Furthermore, the lights in the prototype had a slight delay, which reduced the perceived connection between the participant´s actions and the systems feedback and hindered the understanding of the artefact’s functionality. The participants understood that the different colours had meaning, but where not able to understand this external representation without prior explanation.

The functionality of jumping to switch groups had some unexpected limitations. Other users can hear you jump and see the flashing lights of your tile. This could be perceived as hurtful. You might also be the only user that wants to switch, causing you to feel left out. It would be interesting to try out different responses from the system; would it keep the group the same or try to suggest someone to switch with or maybe even decide to randomize the groups again? It would be interesting to see how conflicts could be avoided using an artifact. The 'CircleUp' design considers this but could focus more on what happens when someone is dissatisfied with the group and wants to switch. The artifact could respond to this in different ways which would create a different social dynamic. It should be noted that what could be perceived as hurtful by the participants, who were university students in their early twenties, might not be considered hurtful, or perhaps more hurtful, by the intended target group of 6 to 12-year-olds.

The positioning of the tiles relative to each other seemed to influence the perceived intended function of the artefact, and what affordances where perceived by the participants. When nearer to each other, participants tried to stand on multiple tiles at the same time or move from one tile to another. They experimented with the system and tried touching the participant next to them to see if this would have an effect. One participant explained that they were trying to get as many different colours to appear as possible. These creative uses of the circles made it a game of its own instead of its intended use. This could be considered for a next iteration. This showed a congruence between the artefact and the findings by Scheepmaker et. al. (2018) and Morris et. al. (2025), who found that artifacts should provide guidelines instead of a set of rules. It can be questioned whether the artefact retains its functionality when users are not provided with instructions on how they should use it, which could significantly steer the joined sensemaking. Perhaps a further iteration should consider a less rigid functionality, which allows children to achieve the same end, making teams that everyone agrees to, but in more different ways.

Reflecting on the process of joining during the Wizard-of-Ozz session was challenging, as the participants were not actually participating in a game before or after using the artifact. A limitation to the artifact is that if a game is already active children must wait for the game to finish to join. Then 'CircleUp' can be used to create new teams. This means that a child cannot use the artifact to join in an ongoing game. This could be considered as hindersome, however, this could make it easier to join a group, as all children ‘exit’ the game and join together after using the artifact. This phase is described in the Honeypot effect (Müller et. al., 2012) where the phenomenon of joining is separated into four

phases. As all children 'exit' the game, form new teams, and start with a new game, this series of actions is also a separated process. These phases can align with the phases of the Honeypot effect where children can observe ongoing play, move towards the tiles, decide to join the interaction by stepping onto the tiles, and can leave the group play after each playing round by not stepping onto the tiles. This also closely relates to the work of Currin (2022) who explained that children feel empowered and have a feeling of agency when they can decide for themselves if they want to join in group play, especially if this can be done in a non-verbal way, like (not) stepping on the tiles.

Based on the prototype testing, it is difficult to say to which extent the artefact would aid children in joining group play and establishing social connections. The artefact allows the child to join the play together with the others and join the group in a non-confrontational fashion. The relatively rigged structure of the artefact's intended functions could hinder the joined sensemaking process of the children, however. The function that allows children to change teams could be perceived as hurtful or could motivate the children to work together to make fair teams. The challenge is that the functioning of the artefact, the shaping of the external representation and the design of the signifiers is all designed by a team that has a limited understanding of the target group. Target group prototype testing and subsequent co-design sessions would likely be required to iterate the system to a fully functioning artefact.

CONCLUSIONS

This paper evaluates the design of an artifact which incorporates the theories of affordances and external representation to improve joined sensemaking between primary schoolers engaged in social group play. Next to the three main theories, related work on constructing guidelines instead of rules, creating a feeling of agency and empowerment, and the honeypot effect were integrated. In the final design, the signifiers of the circles on the tiles enhanced the intended affordances of stepping onto them, which was observed when testing the prototype. The external representation of the tiles, with the lights suggesting a team division, aid children in creating a team division in both a verbal and non-verbal way. Joined sensemaking between the participants was observed during the testing, as the participants were improvising with the prototype, to attempt to determine and develop its meaning. This showed that the artifact can aid in the sensemaking process as an attunement anchor, with which participatory couplings can be formed. This interaction gave inspiration for further iterations of the design which could be worked out in the future.

Further research could focus on the process of joining; the physical and mental steps that occur and the perceived affordances. The current design includes signifiers (circles on tiles) intended to communicate the intended functionality of the artefact. However, a deeper understanding of the ways in which children perceive the affordance of joining play could allow the design to enhance the natural ways of creating meaning, rather than creating meaning for them, and instructing them. A better understanding of the steps involved in joining group play could also inform a redesign that allows children to more gradually join ongoing play. The current design allows the child to observe the group play, and removes the entire group from the play, so that they rejoin together. While this is intended to reduce the pressure on the moment of joining, the current system still involves a moment where the child actively has to join the group, namely when they step on the tiles. With further research the artefact can be designed to facilitate a more gradual variation of this process. This could also remove the restriction that children currently can only use the artefact to join before a round starts. The extent to which this restriction would be experienced as hindersome requires further testing.

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