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# Children's stories and multisensory engagement: Insights from a cultural probes study

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## ABSTRACT

This study builds on child-centred early education models that emphasise active listening to children's voices and follow participatory research methods to accommodate children's expressions. We used the cultural probes method with eleven Norwegian 4-5-year-olds to elicit children's storytelling and multisensory engagement. The children were encouraged to tell a story using open-ended art-making materials provided in a "story box". Children's stories were analysed according to their structural elements with The Social Relationships in Children's Stories (SRCS) tool, and in relation to the intensity of children's engagement of their six senses (vision, hearing, touch, smell, taste and proprioception) during the activity. The SRCS analysis showed that children's stories centred on real characters performing commonly encountered acts, mostly in rural settings (e.g., 'a man pushing a tree' or 'A mother and a baby relaxing in the forest'). Children engaged their senses selectively, in a sequence of different levels of intensity, with the visual and haptic engagement being the most intensively engaged senses during the story-tellings. Children's real-life stories that engage the hidden senses (olfaction, taste and proprioception) could enrich the methods and design of future education studies.

## 1. Introduction

An increasing number of educational studies confront the discordant paradox that even though children are the main recipients of education, they are rarely consulted on the type of education they receive. The paradox arises from the discrepancy between the widely reached consensus on children's right to be heard (Article nr.12 in The United Nations Convention on the Rights of the Child) and the daily reality of education systems where children have little say in. Research that rebalances the status quo adopts participatory research techniques, which actively involve children in the co-creation of knowledge and co-design of learning resources.

In our study, children's active participation was sought to establish their views on the design of a new type of learning experience: sensory stories. Children, as the principal but often silenced stakeholders, were included as informants, so that their ideas can inform and inspire child-centred pedagogies on multisensory learning with stories. The study reported here is the qualitative companion of a quantitative intervention (experiment), focused on the learning impact and pedagogical value of children's senses in experiences with stories. The aim is to identify children's perspectives on the role of sensory engagement in stories and derive design parameters for the creation of storybooks that would respond to children's perspectives. The study's participatory research design aligns with child-

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centred educational philosophies.

### 1.1. Child-centred educational approaches

Early childhood education and care (ECEC) from across the world is characterised with various degrees of child-centred and child-initiated approaches which foreground children's active choice, discovery and independent learning. The core of the child-centred approach is the perception of children as strong and competent beings, who hold views, values and rights that need to be respected and provided for. Teachers and researchers do not interfere with children's actions but take on a more observational role to allow children to express their own ideas. Influences for the child-centred pedagogy spawn the theoretical ideas of several developmental psychologists (e.g., Vygotsky, Rogoff, Bronfenbrenner), philosophers (e.g., Freire, Fröbel), and have their roots in several early childhood education models (e.g., Montessori, Waldorf, and Reggio Emilia). There are significant structural differences among individual countries and their educational models (e.g., universal provision of ECEC, different compulsory ages to start school, quality standards and quality monitoring, public funding and local decision-making). As outlined in the OECD's international reviews of Early Childhood Education and Care Policy in Australia, Belgium, the Czech Republic, Denmark, Finland, Italy, the Netherlands, Norway, Portugal, Sweden, the United Kingdom, and the United States, there are some philosophical differences between how central the child is positioned in national curricula. The emphasis on active listening to children is firmly embedded in the national ECEC curricula in all Scandinavian countries (Ministry of Social Affairs, 2000; Engel et al., 2015; Taguma et al., 2013). The Scandinavian ECEC approach is different from the more teaching- and learning-oriented approach in USA, which centres on cognitive stimulation, literacy and numeracy activities (Lubeck, 2001). In Norway, which is the context for this study, the most recent Norwegian framework plan (Ministry of Education and Research, 2017) explicitly encourages a child-centred pedagogy by supporting children's need for belonging and care and 'enabling children's participation and contribution to the community' (p. 7).

The number of Norwegian ECEC settings exclusively focused on the Reggio Emilia has declined by 25% over the past four years (Hindkjær, 2021). One of possible reasons is that the most recent Norwegian framework plan (FWP) (Ministry of Education and Research, 2017) highlights children's sense of wonder, free play and philosophical thinking within a holistic learning approach (Wolf, 2021). Exploring children's own interests and providing room for them, is considered one of the key distinct features of the Norwegian approach to early childhood education (Alvestad, 2011). Norway thus constitutes a special case in the participatory research literature as the country is known internationally for celebrating children's participation in the society and consulting children as citizens. For example, the Prime Minister Erna Solberg from the Conservative Party held a press conference for children as part of the Covid-19 briefing in March 2020, where children got the opportunity to ask questions and express their concerns regarding the virus. The values of the Norwegian kindergarten curriculum are compatible with those of a participatory research design, and they guided the choice of the methods for the present study.

### 1.2. Participatory research methods with young children

Participatory research methods that actively solicit children's views include various techniques, for example age-adopted interviews, visual methods, such as children's drawings and photographs (e.g., Bland & Sharma-Brymer, 2012), or performative methods such as children's dance or movement (Smagorinsky & Coppock, 1995). Story-telling and story-making are a particularly popular participatory research method in ECEC. Story-telling mobilises implicit and explicit knowledge as it provides a narrative frame for eliciting children's perspectives and addressing the inherent power disparities between adults and children (Thomas & O'Kane, 1998). Digital story-telling has recently risen in popularity for reflecting children's thoughts and emotions with digital media (Solomon, 2010), and make children aware of their own thinking, for example in relation to gender stereotypes (Rubegni et al., 2022). However, children's participation in research needs to be considered critically, with attention paid to the danger of adult-driven, pre-determined choices that often reduce children's participation to production (Mannion, 2007). This danger is particularly present with digital media that rely on templates and pre-designed response options (Dezuanni, 2018; Rousell & Cutter-Mackenzie-Knowles, 2020).

Mindful of this literature, we explored methods that invite children's contribution in a systematic way but that are analogue and open-ended in design. Researchers have used specifically constructed materials to examine children's comprehension, inferencing and other pre-reading skills in their spontaneously narrated stories (Tompkins et al., 2013). In such learning-focused studies, children's storytelling is stimulated with focused narrative conversations between the adult and child (e.g., Peterson et al., 1999), static visual materials (e.g., McConnell, 2011) or moving images featuring story characters and story scenes (e.g., Maine & Shields, 2015). The human-computer interaction literature has a long-established tradition of more child-centred story-telling methods that include children in the co-design of resources and prototypes (Druin, 1999; Guha et al., 2013). Co-design with children does not need to lead to the production of a prototype or a whole new design; it can bring to fore various children's contributions, including 'a cultural emphasis, a needs emphasis, or an age-related emphasis, or it might be a piece of the whole - e.g. the interface look and feel, the reward mechanisms for a game, or the characters' (p. 11, Constantin et al., 2021). Visual methods in co-design are particularly well suited to address asymmetrical adult-child relationships and documenting culturally situated and context-specific data. A popular visual method that draws on children's own self-created analogue artefacts, is the cultural probes method.

### 1.3. Cultural probes

Originally conceived to evoke reflections among elderly community members, cultural probes (Gaver et al., 1999), have since grown into a popular participatory research method for all age groups, including pre-school children. The core of the method is

participants' use of open-ended materials with a "cultural probe kit", in order to explore and express their views on a specific task provided by the researchers. The cultural probe kit includes materials that participants are likely to be familiar with (e.g., writing or painting supplies, cameras) and are given to participants with a task, i.e. a set of instructions from the researchers (Kassan et al., 2020). Cultural probes have been used for facilitating children's views on topics and activities relevant to innovative design and experiences that are often difficult for young children to verbalise. Thus far, cultural probes have not been used with Norwegian kindergarten children, but recent examples from Spain and the UK include the topic of gamification (Rodríguez et al., 2020) or digital reading with parents at home (Vasalou et al., 2020).

To our knowledge, no study has employed cultural probes in relation to children's views on sensory stories. Our specific focus on this aspect of children's participatory research is anchored in the multisensory and multimedia learning theories.

## 2. Theoretical framework

### 2.1. Multisensory and multimedia learning

The exact number of senses is currently being debated in the literature and ranges from the traditional five (vision, hearing, touch, smell and taste) to up to twenty-two. In our study, we limited the focus to six basic senses which are widely acknowledged: vision, hearing, touch, smell, taste and proprioception (sense of body position and movement of limbs). Multisensory learning refers to the stimulation of multiple sensory channels for the purpose of learning. Multisensory stimulation can, for some activities, better support children's learning and remembering than the stimulation of a single or a few channels (Shams & Seits, 2008). Theories that explain this phenomenon are discipline-specific; for example The Theory of Neural Sensory Encoding in neurophysiology (Seilheimer et al., 2014) explains that multisensory processing approximates natural settings, and presents information in a more salient way than learning via a single sensory channel (Jordan & Baker, 2011).

### 2.2. Multimedia learning theory

Multisensory learning studies connected to the use of media, including children's stories, typically draw on Mayer's theory of multimedia learning (Mayer, 2002). The leading hypothesis in Mayer's theory is that different forms of representation can have mutually enhancing or cancelling effects on learning. The theory relies on the cognitive load premise (Sweller, 2011), whereby some representations are beneficial and some overwhelming, depending on how the conveyed information relates to other information to be processed by the child. This theoretical account follows the assumption that separate channels process pictorial and verbal information, and each channel is limited in the amount of material that can be processed at one time. The multimedia learning theory explains why very young children are overwhelmed with multi-sensory stimulation (Ernst & Bühlhoff, 2004), but children between the ages of 5 and 8 begin to derive the same learning benefits from multisensory input as adults (Pettrini et al., 2020).

### 2.3. Child's active involvement in learning

The multisensory and multimedia theories substantiate our project's focus on children's *active* contribution to their learning. Namely, in both theories, children's active participation is essential for benefitting from the sensory and media input. Exploratory neurological studies suggest that learning platforms that capitalise on multi-sensory input and children's *self-produced* actions facilitate learning because they allow the visual and motor systems to interact and form important links for learning (James & Bose, 2011). It is not sufficient for children to watch an activity, for example a teacher tracing a letter shape in sand, but for children to learn they need to actively trace the letters themselves. In our study with cultural probes, children were therefore encouraged to make their own media (stories) and calibrate the cognitive load of their multisensory engagement in the activity.

## 3. Materials and methods

### 3.1. Research questions

The primary objective of this design-oriented research study was to get an insight into children's perspectives on stories and their natural engagement of senses in those. The secondary objective was to use what surfaced to derive a set of design recommendations for child-centred sensory stories in ECEC.

The objectives were pursued with two research questions:

- What role do senses play in children's open-ended, spontaneously narrated stories?
- Which parameters pertaining to story and sensory engagement are important when designing storybooks for children?

### 3.2. Study context

The study took place in a small Norwegian kindergarten with provision for twenty-two children aged between three to five years and four staff members.

Norway offers both private and public kindergartens, both of which enjoy high participation rates (in the 2013 census, the rates

were children 1–2 years: 79.8%; children 3–5 years: 96.6% in 2013, (Engel et al., 2015); with approximately 5% rise in 2021, SSB, 2021). The term “kindergarten” is used to directly capture the Norwegian term “barnehage” (a child’s garden). The kindergarten where the present study took place had several features of the Reggio Emilia approach even though it did not formally associate with any specific educational philosophy. In the kindergarten’s Yearly Plan, the following statement defined how children are viewed to learn in the setting: “The children learn through play and interaction with other children and the staff. We support children’s curiosity and desire to learn in play. The children are introduced to different situations, themes, phenomena, materials and tools that contribute to meaningful interaction and learning. Children should be able to use their whole body and all their senses in their learning processes” (Yearly Plan, 2021–2022).

### 3.3. Participants

The parents of all eleven children (four boys and seven girls, aged between four to five years) attending the eldest age group agreed for their children to participate in the study. All children were native Norwegian speakers. Given the project’s participatory research focus, in addition to children, the teachers’ active participation was encouraged in the study. The kindergarten teacher, who is the co-author of this article, has worked in the kindergarten for eight years. She has a strong research interest and completed a Masters of Early School And Pre-School Education with Integrated Teaching. The teacher has not used cultural probes or similar participatory research method in the kindergarten before.

### 3.4. Cultural probes: story boxes

The cultural probe method consisted of asking the participating children to tell a story as they engage with a “story box”. To access children’s thinking and convey their meanings, we selected a set of open-ended materials for each box. The selection of materials followed literature on design thinking that adopts an exploratory lens to children’s engagement, and recommendations for resources included in child-centred educational philosophies (e.g. wooden figurines with no human face and natural materials). We also consulted two kindergarten teachers about the safety and appropriateness of the selected materials. The included materials were: three thick wooden sticks, two felt bright coloured pompoms, two pompom with animal faces, a selection of pale colour pompoms, a selection of coloured feathers, three wooden people figurines (one big and two small), wooden pencils, white drawing paper and Painting Sketching Paper. All resources were folded inside a paper box, with dimensions of 16 × 18 × 20 cm.

The cultural probes task was a story-telling activity. The story-telling took place in a quiet corner of the kindergarten with children participating either on their own or in pairs. The teacher presented the child, or the child pair, with a story box and encouraged them to explore the materials and recount a story. The children told their stories to the teacher, while the researcher was quietly taking notes with pen and paper. The children were free to manipulate the materials from the story box as they pleased, and their stories could be as long as the children wished.

### 3.5. Ethical considerations


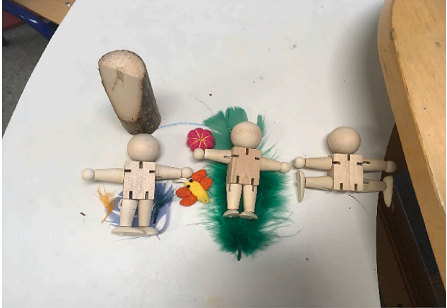



The project was registered with the Norwegian Social Science Data Services and followed best practice in ethical research with children, as set out by The National Committee for Research Ethics in the Social Sciences and the Humanities, which approved the study. The best practice includes seeking the guardians’ and children’s full and ongoing consent to participate in the study, child-appropriate language and data collection methods.

### 3.6. Analysis of the content of children’s stories

The evaluation schemes for children’s stories can be broadly categorised according to theoretical constructs (i.e. evaluation schemes that draw primarily on literary or developmental theories) or positionality (for example the structuralist or reader response perspectives embedded in the evaluation schemes). Literary theories take into account children’s interpretation and recounting of story elements such as selection of story characters, plot, prediction and philosophical reflections (e.g., Purves & Beach, 1972), while developmental theories focus on children’s cognitive development that is revealed through their thinking about story elements such as average length of children’s stories, number of clauses, context-setting information and other aspects revealing complexity of the narrative (Peterson et al., 1999). Structuralist perspectives to children’s stories focus on the textual structure of the narrative, such as the extent to which the story follows the literary conventions of settings, characterisation and plot to convey meaning (Howarth, 2000). In contrast, the reader response perspective (Rosenblatt, 1969) takes into account the subjectivity of each reader and highlights the singularity of the reader’s response in relation to their specific character (personal, cognitive aspects) or global character (cultural, historical aspects).

In this study, we were neither interested in assessing children’s stories in relation to their developmental progress nor in the analytical, academic aspect of their storytelling. We thus needed to choose an analytical scheme that would accommodate both the aesthetic and experiential aspects of texts as theorised by Rosenblatt (1982) but also the unique story symbols that children include in their stories. The latter focus finds resonance in Burke (1945) early work on symbolic acts and the role of symbols in social relationships (Burke, 1989). The Social Relationships in Children’s Stories (SRCS) instrument draws on Burke’s work on symbols in stories that reflect and sustain behaviours and attitudes, and it is also compatible with Rosenblatt’s view on interrelationships between readers and texts. The analytical scheme consists of five categories, as defined and detailed by Kumar (1982): agent (the person, or the

**Table 1**  
 Story summaries based on cultural probes, with photographic illustration.

Nr	Story content	Arrangement of story
1	<p><i>Participants:</i> Two boys, both aged four years  <i>Scene:</i> The story was contained to the box, which served as a spaceship.  <i>Headline:</i> Spaceship that travels to space and lands on the Moon</p>	
2	<p><i>Participants:</i> Two girls, both aged four years  <i>Scene:</i> The objects created a forest.  <i>Headline:</i> Funeral of a little cat killed by the big tree.</p>	
3	<p><i>Participants:</i> A boy and a girl, five years both  <i>Scene:</i> Objects categorised according to colours  <i>Headline:</i>                      No story based on the materials- the materials were sorted according to texture or colour.</p>	
4	<p><i>Participants:</i> A four-year-old boy  <i>Scene:</i> The objects were personified to represent men with vegetables  <i>Headline:</i> About a big man who had a pepper.</p>	
5	<p><i>Participants:</i> A four-year-old girl  <i>Scene:</i> The objects created a circus and the dance show  <i>Headline:</i> A dance show with ladies and flying feathers</p>	

(continued on next page)



**Table 1** (continued)

Nr	Story content	Arrangement of story
6	<p><i>Participants:</i> A four-year-old girl  <i>Scene:</i> Objects represent diverse trees, flowers, animals and humans, divided into two stories.  <i>Headline:</i> Story 1: An owl and cute cat in the forest. Story 2: A mother and a baby relaxing in the forest</p>	
7	<p><i>Participants:</i> A five-year old girl  <i>Scene:</i> The objects were put into a straight line  <i>Headline:</i> Pink pumpkin protected by a woman with magic skills</p>	
8	<p><i>Participants:</i> A five-year-old boy  <i>Scene:</i> Only three objects selected from the box  <i>Headline:</i> Boy pushing a tree</p>	

kind of person, who performed the act depicted in a story); act (what took place in thought or deed); scene (the situation in which the act took place); agency (the means used in the performance of the act); and purpose (the aim or audience to which the act was addressed, p.303). We used all SRCS parameters with the exclusion of ‘purpose’ given that the audience was in our study set as a task for all children. The children recounted their stories individually or in pairs, so the audience was limited to the audience of the teacher, researcher and in the case of child pairs, the child peer.

### 3.7. Analysis of sensory references in children’s stories

The measurement of children’s sensory preferences in education elicits contrasting perspectives on evaluating children’s

multisensory engagement. From the developmental perspective, children’s sensory preferences can be gauged from studying their sensory exploratory behaviours (i.e., smelling, licking, spitting, refusals, and acceptance) in response to new stimuli (Moding et al., 2020). A widely used clinical tool used in evaluating children’s sensory preferences is the Short Sensory Profile (Dunn, 1999), which is a questionnaire completed by children’s parents with the intention to detect sensory processing difficulties. The clinical evaluation approaches stand in sharp contrast to those promoted by childhood studies concerned with embodiment and tacit ways of children’s own perspective on their dynamic, evolving and highly physical sensory experiences (Mackley et al., 2015). With no intention to fix the ‘human/nonhuman entanglement, chance and unpredictability’ (p.500) of children’s sensory experiences, Hackett et al. (2018) do not provide any evaluation schemes but rather embrace an abstract, embodied, ongoing and improvisatory process.

We did not aim to provide a developmental description of children’s sensory engagement, but we needed a tool to systematically evaluate children’s experience of, and references to, six senses. Given the absence of an existing suitable evaluation scheme, we devised a simple method that draws on the multisensory theory in that it pays attention to children’s engagement of individual senses and their intensity, integration and stimulation with diverse materials. Our coding scheme focused on high, medium and low intensity and the individual and joint engagement of senses for each child. Data on children’s sensory engagement was integrated into a spider diagram, which provides a condensed visual language for expressing the relationships between variables, and a useful way for tracking new phenomena with several sources of data (Howse et al., 2005).

**4. Interpretation**

Overall, eight cultural probes took place, with eleven children divided into three pairs and five children recounting their stories individually. The pair-based or individual participation was decided by the teacher, based on her knowledge of the classroom dynamics and the children’s preferences.

*4.1. The content of children’s stories*

Table 1 summarises the key ideas discussed in individual children’s stories, with an accompanying photo of the final arrangement of materials in each cultural probe. The Headline for each story is based on children’s own words; the objects’ description is the researcher’s summary.

Tables 2–5 describe children’s stories according to the SRCS categories. Table 2 captures the analysis of the key person performing the story in individual children’s story accounts. For CP1, the main agent was a man flying to space; for CP2, there were both human and non-human agents, with three adults burying a small cat. In CP3, the children recounted personal stories about what recently happened in their lives (e.g. the girl lost the front tooth), so the main agent in this case was the child herself. CP4 was a story about a man and a pepper, with both the human and non-human characters positioned as story heroes. For CP5, the girl shared a story about a group of ladies dancing in a circus. The two stories in CP6 complemented each other in that one story was driven by human and the other story by non-human agents. Story in CP7 was similar to CP4 in that it involved an adult human and a vegetable, but while in the boy’s story, the pepper performed actions, in the CP7 story, the vegetable was treated as an object manipulated by the adult. This was similar to CP8, where the human agent interacted with the object (the tree) and the agent was a child.

The Scene Analysis mapped on the simple story-plots described by the children (as captured in Headlines in Table 1) and Kumar’s (1982) descriptions of types of act (see Table 3).

In Table 4, we categorised children’s stories according to the environment where they took place. The Rural category, which included nature-based environments such as forest or trees, was most popular for children’s stories.

For the last SRCS analysis category, we paid close attention to children’s descriptions of the main agents who steered the actions in their stories, that is to say which character was in control of the story-plot and which character made choices that advanced the story. There was a lot of variation among individual stories for this type of categorisation, with each story displaying a different configuration of means used in the performance of the story acts.

*4.2. Sensory references in children’s stories*

We report children’s multisensory engagement with first a short description of how the children engaged with individual senses in each of the CPs, followed by our estimation of the intensity of engagement with each sense.

**Table 2**  
The agent who performed the act depicted in a story.

CP	Agent Human	Agent non-human	Child	Adult	Group agent
1	X	–	–	X	–
2	X	X	–	X	X
3	X	–	X	–	–
4	X	X	–	X	–
5	X	–	–	X	X
6	X	X	X	X	X
7	X	–	–	X	–
8	X	–	X	–	–

**Table 3**

The type of act that took place in thought or deed.

Type of act	1	2	3	4	5	6	7	8
Acts involving an attempt to survive under difficult circumstances	–	–	–	–	–	x	x	x
Acts involving encounter with evil characters	x	x	–	–	–	–	x	–
Acts of revenge	–	–	–	–	–	–	–	–
Acts which consist of doing good	–	x	–	–	x	x	x	–
Acts in which achievement of one’s aim is involved	–	–	x	–	–	x	–	x
Acts performed out of deference to another	–	x	x	–	–	–	x	x
Acts in which making a choice leads to results	x	x	–	–	–	–	–	x
Acts involving routine life situations	–	x	x	x	x	x	–	–
Acts in which the agent responds to a supernatural/fantastic character/experience	x	–	–	–	x	–	x	–
Acts involving agent’s response to coincidences	–	–	–	–	–	–	–	–

**Table 4**

The scene or the situation in which the act took place.

CS	Urban	Rural	Unidentifiable
1	x	–	–
2	–	x	–
3	–	–	x
4	–	–	x
5	–	X	–
6	–	X	–
7	–	X	–
8	–	X	–

**Table 5**

The agency, or the means used in the performance of the act.

Type of act	1	2	3	4	5	6	7	8
Personal quality or idea	–	x	x	–	–	–	x	x
Family	–	x	–	–	–	x	–	–
Peers	x	–	–	–	–	–	–	–
Community	–	–	–	x	x	–	–	–
Institutions	–	–	–	–	–	–	–	–
Non-human	–	x	–	–	–	x	–	–
Situation improves itself	–	–	x	–	–	–	–	–

CP1: The two boys moved around the table and spoke loudly about what their story was about, completing each other’s sentences. They made sounds with the wooden sticks by beating them and against the table surface. They threw the people figurines up in the air exclaiming it was a space-ship. One of the figurines landed into the nearby bin in the classroom, which made the boys laugh and comment that the spaceship does not smell spaceship but ‘rubbish’ (søppel) and ‘poo’ (bæsj).

CP2: The two girls recounted the whole story by whispering. They only used the pale coloured materials from the boxes. The bright coloured feathers were hidden behind the bigger objects in the box and later by the people figurines on the table surface. There was no mention of smell or taste during the story. Touch was central in exploring all the materials from the box. The whole activity was sedentary.

CP3: Both the boy and girl translated the story activity into a sorting task in which they grouped the objects together according to their colours. In addition, they used the coloured pencils to colour in larger pieces of paper. This background was used for more visual categorising of the materials; for example, they coloured the paper green and placed a green feather on the green background. The boy added eyes and smile to the faceless human figure. There was no mention of any edible or olfactory items. The girl shared a personal story with the teacher, the boy was quiet during the whole activity. There was minimal bodily movement by the children. Both used touch to explore all materials but texture did not seem to influence their colour-dominant categorisation of the materials.

CP4: The boy explored all materials by first taking them out of the box, then arranging them in relation to colour, then putting some of them back in the box. He touched the selected objects several times and brought the feather to his cheeks to tickle himself. ‘The box smells like paper!’ He exclaimed several times after he buried his nose in it. He used the wooden sticks and figurines to make sounds. He repeatedly referred to the colourful pompom as a pepper.

CP5: The girl examined all the objects in the box with her first three fingers and then with the entire hand by taking the objects out and putting them back again. She placed the feathers on top of the taller objects. She commented several times ‘nice colours’. She appeared irritated that the feathers flew away when she breathed towards them and wanted to glue them onto the trees. After an almost silent exploration, she got up and performed her story by dancing.

CP6: Both girls immediately took the objects out from the box and created a forest, house, beds and pillows for cats, owls, ‘mummy’



and baby. The soft texture of the feathers dominated the story – the harder objects were stroked before they were lied down on the feathers. No objects were used to or commented about as to represent sounds, food- or odour-related items. Both girls chose to sit during the whole activity.

CP7: The girl was quiet during the whole activity with careful movements of touching and holding the objects. She selected the pink pompom and said it was a pumpkin with a candy scent. No objects were used to make sound. The girl preferred to sit during story-telling.

CP8: The boy hesitated to touch the objects in the box. He sat down quietly, then selected three and placed them together without making any sounds. He selected materials with the least bright colour palette. He spoke little and when prompted said there was no smell in his story.

Table 6 captures the intensity of children’s sensory engagement on a scale of 1–3, with 1 = low intensity; 2 = moderate and 3 = high for each cultural probe, and Fig. 1 summarises the intensity graphically across all cultural probes.

5. Discussion

5.1. Theoretical and empirical contributions

This study used a participatory research design to explore children’s viewpoints on stories and multisensory engagement. In classic design-oriented literature, the focus is on children’s preferences for new design, prototypes or already created materials (e.g., print and digital books, Cesário et al., 2016). Our study is unique in that we encouraged children to make their own stories with open-ended materials with no restrictions on what the story could look, sound or be like. This flexible, open-ended orientation towards children’s participation corresponds to child-centred pedagogical approaches in several socio-cultural frameworks, including the curricula of Reggio Emilia used internationally or the national Norwegian curriculum. The approach allowed us to bring to fore aspects of children’s stories that have not been reported in the literature before. In particular, we found that the children engaged their senses selectively, with dominant engagement of the visual sense in terms of selection and engagement of colours and touch sense in terms of exploration different textures with their fingers and hands. Smell introduced a fun element into one of the children’s stories, and was connected to the engagement of other senses, either with direct movement or with imaginary tastes attributed to the colourful objects. Although some children engaged their senses with a high intensity by dancing and making sounds with wooden sticks, others purposefully selected muted colours and regulated the noise levels by whispering. Children’s selective sensory engagement was captured in the spider-map, which illustrates that children did not use all senses with high intensity. Rather, the children engaged their senses in a selective sequence, thus avoiding a cognitive overload and showing agency in their multisensory engagement.

The patterns we note in our data correspond to the multisensory and multimedia theories that describe limitations in cognitive processing and the need to avoid overstimulation and overwhelmingness with concurrent multimedia stimulation (Mayer, 2002). We have also noted some cross-modal associations between the engagement of individual senses, for example the sense of smell being engaged simultaneously with the sense of touch. We also noted cross-modal associations between vision and smell, when the child attributed “candy smell” to a pink pompom, which she described as a flower in her story. We also noted the correspondence between touch and smell, in that children attributed other sensory properties to materials that had a distinct texture (soft feathers were used to engage the bodily movement and hard wooden materials were used to make sounds).

The sense of touch seemed to be a central precursor for the engagement of other senses: children carefully explored the objects through touch before they smelled them, or before they made sounds with them. The children controlled the sensorial input by bringing the objects closer or pushing away from their bodies (e.g. blowing feathers away or diving their nose inside the paper box), thus showing the ability to calibrate sensorial input according to the material properties of the objects. Thus far, such associations were noted in design projects in adult consumer literature (e.g., Piqueras-Fizman & Spence, 2012), but have not been explored with children in relation to their stories. We propose that the open-ended method of cultural probes allowed room for natural demonstration of the sensorial intensity selected by the children.

5.2. Methodological contributions

The cultural probes method proved to be a sensitive and useful tool to elicit children’s spontaneous stories, without the need for any extensive instructions or expensive prompt materials. The children engaged with the materials without any hesitation, and they shared

**Table 6**  
Engagement of senses according to their intensity, as demonstrated by children’s active use of the individual senses during story-telling.

CP	Vision	Hearing	Touch	Smell	Taste	Propr.
1	H	H	M	M	L	H
2	M	L	H	L	L	L
3	H	L	M	L	L	L
4	H	H	H	H	H	M
5	H	L	M	L	L	H
6	H	L	H	L	L	L
7	H	L	M	H	H	M
8	L	L	M	L	L	L

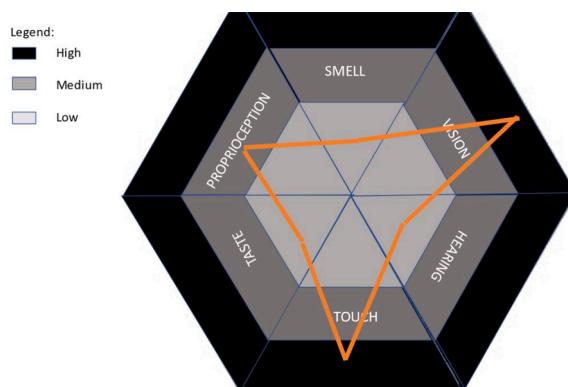


Fig. 1. Spider diagram of intensity of engagement of individual senses across the cultural probes.

stories that were reflective of their developmental stage. Previous research shows that when asked to spontaneously narrate a story, five-year-old children predominantly refer to concrete actions of the story characters (Trabasso & Nickels, 1992), and they perceive supernatural (or “magic”) properties in ordinary story events (L’Ecuyer, 2014). In our study, there was a clear preference among the children to recount stories based on real-life story plots, with common adult story characters performing commonly encountered acts. The use of the SRCS analytical instrument afforded an understanding of both children’s experiences as well as their perception of their own and others’ agency in the story — aspects relevant for a participatory research design that emphasises the agency of users and their subjective experiences in design discussions.

### 5.3. Design implications

All participating children repurposed the materials inside their story books and gave them functionalities relevant for their stories: the feather stood for a pillow for the mother to relax and wooden sticks became musical instruments. This repurposing of story materials shows the rich fantasy worlds children have and highlights the importance of keeping story materials open-ended if they are to support children’s own expressions.

We also noted a clear preference for children to use touch to explore the materials and highlight the importance of analogue material properties, such as diverse textures, weight and hardness, in designing child-centred story materials. This observation is particularly relevant in light of the growing literature on digital story-telling that engage predominantly the visual, audio and tactile senses (Kucirkova, 2021). The participatory research literature is surprisingly sparse in describing how children engage the quieter senses, such as the sense of smell, taste or proprioception. A cursory reference to scratch-and-sniff books can be found in early studies with blind children (e.g., McGee & Tompkins, 1982) and practice-oriented studies focused on motivating children to read (e.g., Hampshire, 2011). “Edible books” are described as an innovative book design method (Alaca, 2019) and the use of book bridges in stimulating children’s proprioception in ECEC (Kucirkova, 2021). Sensory books that would stimulate children’s sense of smell, taste and proprioception might represent a new frontier in child-centred stories.

## 6. Study limitations and future research directions

Our study was neither a group comparison nor intervention study, and it is therefore not possible to describe any of our observations with causality attributes. The social context of a Norwegian kindergarten and the particular nature of the open-ended materials used for prompting children’s stories would have influenced our data interpretations. It could be that for this age group and the particular methodological context, a fictional story with a realistic story plot offered a safe narrative frame. The cultural probes materials were selected to be as open-ended and diverse as possible, but it could be that some of the material properties of the objects inside the story boxes shaped children’s engagement. Although we purposefully selected materials with different textures and visual properties, we did not attempt to alter the audio, olfactory or taste of the individual materials. The activities happened for children at various point of the day so they hunger levels may have affected the amount to which they attributed gustation-related properties to the individual objects, and how much they perceived the natural scents of the materials (e.g., that the paper box smelled like paper as commented on by one of the boys).

The CP method offered children the opportunity to recount story events according to their existing knowledge of the world, *in-situ* preferences and interpretation of the materials. This is in line with child-centred educational philosophies and child-centred design literature that emphasise open-ended methods to bring to fore the natural expression of children’s abilities. The teacher was present at all retelling activities, and we cannot know whether the children engaged some senses in higher or lower intensity because of what they were used in the kindergarten. Nevertheless, given that teachers are well-positioned to enhance the educational value of ECEC research and gauge its practical relevance for the classroom (Ness, 2019), the teacher’s active participation in the study can be perceived as the study strength.

In conclusion, our participatory research design study showed how the use of open-ended materials can surface the rich multi-sensory world of children's stories. In line with our motivation to listen to children's voices, we recommend the use of cultural probes as a suitable method for eliciting children's spontaneously narrated stories that can reveal unexpected parameters pertaining to sensory engagement. We recommend the exploration of the engagement of hidden senses (olfaction, taste and proprioception) as an exciting future research agenda in ECEC story research.

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