

Smell as a Learning Material

Shaping Participation in Small Group Second
Language Activities

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Abstract

This thesis explores how smell functions as an interaction material in small group second language activities. Using a Research through Design approach, and material exploration, a series of iterative activities were developed and tested with adult learners. The study focused on participation and interaction rather than language performance or learning outcomes. Data was collected through video recordings, observation, field notes, and interviews, and analysed using qualitative interaction analysis. The findings show that smell reshaped interaction differently from visual and verbal materials. Because smell does not carry a clear shared meaning, participants had to talk through their interpretations, compare responses, and work together to make sense of what they smelled. This pushed interaction toward more exploratory and collaborative forms, though it also produced hesitation and moments of silence. The study contributes to interaction design research and educational institutions by positioning smell as an active interaction material that shapes participation and collaborative meaning making in language learning.

Keywords: Olfaction, Interaction design, Participation, Learning, Multisensory interaction, Second language interaction, small group interaction

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To my mother, my sisters Linda, Loura, and Leen and to every friend who stood by me when this felt impossible. You just believed. On the hard days, that was everything.

"I did it. Finally."

This one is for you.

"It always seems impossible until it is done."

Nelson Mandela

Table of Contents

1	INTRODUCTION.....	7
1.1	RESEARCH CONTEXT	7
1.2	PROBLEM AREA	8
1.3	RESEARCH AIM	8
1.4	RESEARCH QUESTION.....	8
2	BACKGROUND.....	9
2.1	LANGUAGE AS SOCIAL INTERACTION.....	9
2.2	PARTICIPATION IN SMALL GROUP INTERACTION	9
2.3	MULTISENSORY INTERACTION DESIGN	9
2.4	OLFACTION AS INTERACTION MATERIAL.....	10
2.5	GAP IN RESEARCH	10
3	RELATED WORK.....	11
3.1	SMELL IN INTERACTION DESIGN	11
3.2	SMELL IN LEARNING OR ACTIVITIES	11
3.3	GROUP INTERACTION AND LANGUAGE ACTIVITIES.....	11
4	METHOD	12
4.1	RESEARCH APPROACH, RESEARCH THROUGH DESIGN (RTD)	12
4.2	MATERIAL EXPLORATION	12
4.3	DESIGN PROCESS TOOLS.....	12
4.3.1	<i>Sketching</i>	12
4.3.2	<i>Brainstorming</i>	12
4.3.3	<i>Playtesting</i>	13
4.3.4	<i>MDA informed design</i>	13
4.4	DEFINING PARTICIPATION	13
4.5	DATA COLLECTION	14
4.5.1	<i>Observation</i>	14
4.5.2	<i>Video and audio recording</i>	14
4.5.3	<i>Interview</i>	14
4.6	INTERACTION ANALYSIS	14
4.7	A/B CONDITIONS.....	14
4.8	ETHICAL CONSIDERATIONS	15
4.9	USE OF AI TOOLS	15
5	ACTIVITY DESIGN.....	16
6	DESIGN PROCESS.....	17
6.1	SESSION 1, HYLLIE PARK FOLKHÖGSKOLA.....	17
6.1.1	<i>Design Purpose</i>	17
6.1.2	<i>Context and Setup</i>	17
6.1.3	<i>Design Decisions</i>	17
6.1.4	<i>Control Condition</i>	17
6.1.5	<i>Design Reflection</i>	18
6.2	SESSION 2, KVARNBYS FOLKHÖGSKOLA	18
6.2.1	<i>Design Purpose</i>	18
6.2.2	<i>Design Changes</i>	18
6.2.3	<i>Familiarity as a Design Element</i>	19
6.2.4	<i>Control Condition</i>	19
6.2.5	<i>Design Reflection</i>	20
6.3	SESSION 3, GLOKALA FOLKHÖGSKOLA	20
6.3.1	<i>Design Purpose</i>	20
6.3.2	<i>Brainstorming</i>	20

6.3.3	<i>Sketching and Design Development</i>	21
6.3.4	<i>MDA to Structure the Activity</i>	23
6.3.5	<i>Game Dynamics Structure</i>	23
6.3.6	<i>Introducing Rule Change</i>	24
6.3.7	<i>Smell Choice and Use of Images</i>	24
6.3.8	<i>Rules</i>	25
6.3.9	<i>Design Reflection</i>	25
6.4	SESSION 4, KVARNBYS FOLKHÖGSKOLA	25
6.4.1	<i>Design Purpose</i>	25
6.4.2	<i>Design Change: From Competition to Playfulness</i>	25
6.4.3	<i>Playfulness as Design Approach</i>	26
6.4.4	<i>Smell and Image Materials</i>	26
6.4.5	<i>Smell as Experienced by Participants</i>	27
6.4.6	<i>Design Reflection</i>	27
6.5	SESSION 5, KVARNBYS FOLKHÖGSKOLA	28
6.5.1	<i>Design Purpose</i>	28
6.5.2	<i>Design Change: Structured Turn Taking</i>	28
6.5.3	<i>Design Reflection</i>	28
6.6	SESSION 6, HYLLIE PARK FOLKHÖGSKOLA	29
6.6.1	<i>Design Purpose</i>	29
6.6.2	<i>Design Change: Introducing Carnavalesque Interaction</i>	29
6.6.3	<i>Smell and Image Materials</i>	30
6.6.4	<i>Design Reflection</i>	30
7	RESULTS	31
7.1	SESSION 1, HYLLIE PARK FOLKHÖGSKOLA	31
7.1.1	<i>Word Condition</i>	31
7.1.2	<i>Familiar Smell (orange)</i>	31
7.1.3	<i>Participation Distribution</i>	31
7.2	SESSION 2, KVARNBYS FOLKHÖGSKOLA	33
7.2.1	<i>Word Condition</i>	33
7.2.2	<i>Familiar Smell (Cedrat)</i>	33
7.2.3	<i>Unfamiliar Smell (Ylang extra)</i>	33
7.2.4	<i>Participation Distribution</i>	33
7.3	SESSION 3, GLOKALA FOLKHÖGSKOLA	35
7.3.1	<i>Smell Condition</i>	35
7.3.2	<i>Participation Distribution</i>	35
7.4	SESSION 4, KVARNBYS FOLKHÖGSKOLA	36
7.4.1	<i>Smell Condition</i>	36
7.4.2	<i>Picture Condition</i>	36
7.4.3	<i>Participation Distribution</i>	36
7.4.4	<i>Interview Results</i>	37
7.5	SESSION 5, KVARNBYS FOLKHÖGSKOLA	37
7.5.1	<i>Smell Condition</i>	37
7.5.2	<i>Picture Condition</i>	37
7.5.3	<i>Participation Distribution</i>	38
7.5.4	<i>Interview Results</i>	39
7.6	SESSION 6, HYLLIE PARK FOLKHÖGSKOLA	39
7.6.1	<i>Smell Condition</i>	39
7.6.2	<i>Picture Condition</i>	40
7.6.3	<i>Participation Distribution</i>	40
7.6.4	<i>Interview Results</i>	41
8	INTERACTION PATTERNS	42
8.1	PARTICIPATION DISTRIBUTION	42
8.2	TURN TAKING BEHAVIOUR	42
8.3	COLLABORATIVE DYNAMICS	42

8.4	WITHDRAWAL AND SILENCE	42
8.5	DIFFERENCES BETWEEN CONDITIONS	43
9	DISCUSSION	44
9.1	SMELL AS INTERACTION MATERIAL	44
9.2	HOW SMELL SHAPES PARTICIPATION	45
9.3	AMBIGUITY AND MEANING NEGOTIATION	46
9.4	IMPLICATIONS FOR INTERACTION DESIGN	47
9.5	LIMITATIONS OF THE STUDY	49
10	CONCLUSIONS.....	50
10.1	KEY FINDINGS.....	50
10.2	CONTRIBUTION TO INTERACTION DESIGN	51
10.3	FUTURE WORK	52
11	REFERENCES.....	53
12	APPENDIX	56
12.1	INTERVIEW Q	56
12.2	FAMILIAR AND UNFAMILIAR TEST	57
12.3	TABLES (INITIATION / RESPONSE / CB / WITHDRAWAL).....	57
12.4	ACTIVITY INSTRUCTIONS	58
12.4.1	<i>Session 1</i>	58
12.4.2	<i>Session 2</i>	58
12.4.3	<i>Session 3</i>	58
12.4.4	<i>Session 4</i>	58
12.4.5	<i>Session 5</i>	59
12.4.6	<i>Session 6</i>	59
12.5	CONSENT FORM	60

1 Introduction

Small group activities are important for understanding how people use a second language (Gibbons, 2010). In this thesis, language use is not treated as only individual performance or correct answers. Instead, it is understood as something that happens through participation, communication, and shared activity between participants (Gibbons, 2010).

Interaction design has often focused on visual and auditory materials such as text, images, and speech. Smell is less explored and is often treated as a background element instead of something that actively shapes communication between people (Maggioni et al., 2019). Previous research also shows that sensory materials can influence how people engage, respond, and participate during activities, even when they do not directly improve learning outcomes (Løkken et al., 2025).

This thesis explores how smell can be used as an interaction material in small group activities where participants use a second language. The study does not focus on language improvement. Instead, it examines how smell shapes participation, including who speaks, how participants respond to each other, and how ideas are developed collaboratively during the activity.

1.1 Research Context

Second language activities in adult education in Sweden are expected to focus on communication and active language use rather than individual exercises (Skolverket, 2022). Speaking and interaction are not only outcomes of language learning, but also conditions through which learning happens (Gibbons, 2010). This study was conducted at folkhögskolor, which are adult education institutions outside the compulsory school curriculum. These settings were suitable because participants are grouped by language level, which meant that large differences in language ability were less likely to affect the interaction.

Research in multisensory interaction design shows that sensory materials such as smell can influence how participants engage and interact during activities (Maggioni et al., 2019). Smell functions differently from visual materials, which makes it relevant to explore how it shapes participation during small group second language activities.

1.2 Problem Area

Research on multisensory interaction design and research on second language interaction have rarely been connected directly. Existing work in interaction design shows that sensory materials such as smell can influence engagement and experience, but these studies often focus on individual perception or user experience rather than interaction between participants (Maggioni et al., 2019). Garcia Ruiz et al. (2021) also note that olfactory systems rarely address social or collaborative contexts.

At the same time, research on second language interaction emphasizes participation, communication, and building ideas together, but it mainly focuses on verbal or visual materials (Gibbons, 2010). Hall (2020) similarly focuses on interaction during second language use but does not include sensory materials such as smell.

Because of this, there is still limited understanding of how smell shapes participation during group interaction who speaks, how participants respond to each other, and how ideas are developed collaboratively during second language activities.

1.3 Research Aim

The aim of this research is to explore how smell, used as an interaction material, shapes participation and interaction in small group activities where participants use a second language. The study does not focus on learning outcomes or language performance. Instead, it examines how smell shapes communication, responses, turn taking, and collaborative interaction during the activity.

1.4 Research Question

The main research question guiding this study is:

How does smell as an interaction material shape participation and interaction during second language use in small group activities?

To support this question, the study also explores:

- How smell influences turn taking and response patterns between participants
- What interaction patterns emerge when smell is used compared to non smell conditions
- How familiar and unfamiliar smells influence participation and interaction
- How participants describe and interpret smell during the activity

2 Background

2.1 Language as Social Interaction

Language use in second language contexts is not only an individual cognitive process. It develops through social interaction between participants, where meaning is created collaboratively through communication, response, and shared activity (Gibbons, 2010; Hall, 2020). From this perspective, participation is central to how language functions during interaction. What participants say, how they respond to each other, and how they coordinate actions together are all part of how language is used and developed in group settings (Goodwin & Heritage, 1990). This understanding of language as a social and participatory practice forms the basis for examining how interaction develops during the activities in this study.

2.2 Participation in Small Group Interaction

In this study, participation is understood as visible action during interaction, not as internal states such as motivation or intention (Goodwin & Heritage, 1990). This includes who initiates ideas, who responds, how turns are shared, and how ideas are developed together between participants.

Participation develops moment by moment through social interaction and can change depending on the activity structure and the materials involved (Goodwin & Heritage, 1990). Small group settings are useful for studying this because interaction patterns are easier to observe when participants respond to each other, negotiate meaning, and share conversational space throughout an activity (Mercer, 2000).

2.3 Multisensory Interaction Design

Interaction design has traditionally focused on visual and auditory materials such as screens, text, and speech. More recent work explores how senses beyond vision and hearing can shape experience and social interaction between participants. Sensory elements such as touch, sound, and smell can influence attention, engagement, and how communication develops during collaborative activities (Maggioni et al., 2019). This shows that multisensory design has a place for exploring materials that are more open to interpretation and may shape interaction in different ways from text or images.

2.4 Olfaction as Interaction Material

Smell is different from visual or sound materials. Unlike images or words, smells are often difficult to describe, and different people can connect the same smell to different memories and experiences (Stevenson, 2010; Herz, 2004). This openness to explanation can support interaction. When participants try to describe a smell, they may compare ideas, discuss different interpretations, and respond to each other's associations, which can create conversation and collaborative interaction (Majid & Burenhult, 2014). Instead of only working as background stimulation, smell can become part of the interaction itself. In group activities, smell can shape how participants take turns, respond to each other, and build meaning together during the activity.

2.5 Gap in Research

The concepts discussed above participation, multisensory design, and olfaction have rarely been studied together in the context of second language interaction. This study addresses that gap by examining how smell shapes participation during small group second language activities.

3 Related work

3.1 Smell in interaction design

Maggioni et al. (2019) show that smell in interaction design has mainly been used in virtual environments and immersive systems to support atmosphere and sensory experience. Garcia Ruiz et al. (2021) similarly show that olfactory systems often focus on individual engagement, such as attention, memory, or emotional response, rather than interaction between participants. Both studies show that smell in design has rarely moved beyond individual experience into social or collaborative settings.

3.2 Smell in learning or activities

Løkken et al. (2025) explored how smell influenced participation during shared reading activities with children. Their findings showed that smell did not significantly improve learning outcomes, but it did influence attention and participation during the activity. The activity changed how participants interacted, even when performance itself did not improve.

However, their study focused on shared reading in a structured setting where participation was connected to a common text. Thomson and Kucirkova (2025) similarly argue that olfactory stimuli have potential in reading and literacy contexts, though they note that more research is needed to understand how smell supports struggling readers in practice.

This study differs in two main ways.

- First, the activities were designed around smell as the main interaction material rather than as a supporting element.
- Second, the focus is on group interaction between adult second language learners, where meaning is created through conversation, interpretation, and collaborative responses rather than reading.

3.3 Group interaction and language activities

Gibbons (2010) and Mercer (2000) show how small group activities create opportunities for participants to negotiate meaning and build ideas collaboratively through talk. However, the activities in this body of work are built around verbal and visual materials. Sensory materials such as smell are not included. This study introduces smell as the primary interaction material in a group second language activity, examining how it changes the way participants interact and build meaning together.

4 Method

4.1 Research Approach, Research through Design (RtD)

This study follows a qualitative Research through Design approach (Zimmerman et al., 2007). RtD is a design research method where knowledge develops through designing, testing ideas, and reflecting on interaction during the design process (Vaughan, 2017). Instead of focusing on hypothesis testing or controlled experiments, RtD explores design situations through practical design work.

The iterative structure of RtD also supported reflection throughout this project. Observations and analysis from earlier sessions helped shape later design changes and activity iterations (Zimmerman et al., 2007). This study is also informed by interaction analysis and video research approaches, where interaction is studied within real social situations (Jordan & Henderson, 1995; van Amstel, 2014).

4.2 Material Exploration

Material exploration is an approach in interaction design research that focuses on understanding the qualities and possibilities of materials through exploration and experimentation (Wiberg, 2013). Instead of focusing only on final outcomes, the approach treats exploration itself as a source of knowledge.

4.3 Design Process Tools

4.3.1 Sketching

Sketching is a way of exploring and developing early ideas through simple drawings and visual sketches (Buxton, 2007). It supports thinking about interaction, activity flow, and different design possibilities. Sketching supported the development of activity ideas and interaction structures before testing.

4.3.2 Brainstorming

Brainstorming explores ideas and concepts during the early design process (Vaughan, 2017). The method helped create early ideas about activity structures before any testing began and interaction possibilities before development.

4.3.3 Playtesting

Playtesting is a method for exploring how participants engage with rules, materials, and interaction structures during an activity (Fullerton, 2014). Through repeated testing, it becomes clear what works, what interrupts interaction, and what needs to change.

4.3.4 MDA informed design

The MDA framework stands for Mechanics, Dynamics, and Aesthetics (Hunicke et al., 2004). The framework is used in game and interaction design to understand how rules and interaction structures shape participant experience. Mechanics refer to the rules and structure of an activity, dynamics refer to how interaction develops during participation, and aesthetics refer to the overall experience created through the activity.

4.4 Defining Participation

Participation refers to how participants take part in the activities through visible actions and communication (Goodwin & Heritage, 1990). In this study, participation was examined through how participants started ideas, responded to others, collaborated during storytelling, and interacted within the group. Four analytical categories were used to analyse participation during the activities: Initiation (I), Response (R), Collaborative Building (CB), and Withdrawal (W), as shown in (Figure 1). These categories supported the analysis of how participation developed across different activity conditions and interaction structures. This definition follows research where participation is understood through visible social interaction rather than internal states such as motivation or engagement (Goodwin & Heritage, 1990; Yeh, 2019).

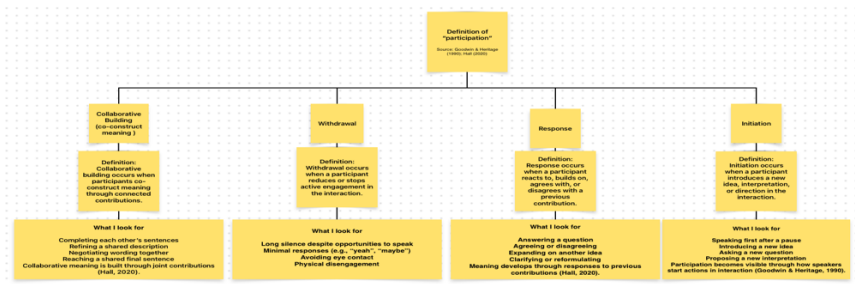


Figure 1. Analytical categories of participation used in this study (based on Goodwin & Heritage, 1990; Hall, 2020).

These four categories are shown in (Appendix 12.3) and were applied consistently across all sessions to analyse how participation developed under different conditions and materials, making it possible to compare interaction patterns between smell and non smell conditions.

4.5 Data Collection

4.5.1 Observation

Observation is a method for studying how participants interact and respond within a specific activity or social context (Bryman, 2018). In interaction design research, observation makes it possible to study how participants act, respond, and interact during the activity.

4.5.2 Video and audio recording

Video and audio recordings provide a way to return to the activities and examine interaction in detail after the sessions (Jordan & Henderson, 1995). The recordings made it possible to go back and examine specific moments of turn taking, response, and silence in detail.

4.5.3 Interview

Interviews are a method where a researcher talks with participants to understand their experiences, thoughts, and reflections about a specific topic (Kvale & Brinkmann, 2009). In interaction design research, interviews give participants space to describe what the activity felt like from their perspective.

4.6 Interaction Analysis

Interaction analysis is a method for studying how people communicate and interact during activities and social situations (Jordan & Henderson, 1995). The method focuses on what participants do during interaction when they speak, how they respond, and when they go silent. In this study, interaction analysis supported the examination of how participants interacted during the smell activities and how participation developed through discussion, collaboration, and hesitation.

4.7 A/B Conditions

The smell and non smell conditions were included to compare how different interaction materials influenced participation and communication during the activities. Interaction Analysis makes it possible to examine and compare interaction patterns across different activities and situations (Jordan & Henderson, 1995). To support comparison, the overall activity structure remained similar across the conditions. This comparison approach was inspired by A/B testing, where one part changes while the rest of the activity stays the same to compare differences between conditions (Kohavi et al., 2020).

4.8 Ethical Considerations

All participants received information about the purpose of the study before taking part in the activities. Participation was voluntary, and participants could leave the study at any time without giving a reason. Consent was collected before the sessions were recorded.

Video and audio recordings were only used for research purposes, and participant information was handled confidentially. Participants were anonymized in the analysis and presentation of the findings. Because the activities included smell materials, participants were informed about the scent before participation and asked about possible allergies or sensitivities.

The study followed ethical guidelines for research involving human participants (Swedish Research Council, 2017). Information and consent forms are included in (Appendix 12.5).

4.9 Use of AI Tools

AI tools were used in limited ways during parts of the design and documentation process. Google Gemini was used to transform hand drawn sketches into clearer digital style sketches for presentation purposes. The original ideas, interaction structures, and activity concepts were created by me.

DeepSeek AI was also used during the interview preparation process to generate examples of open ended interview questions. The prompts were conversational rather than special research prompts. Final interview questions, selection, and adaptation were decided by me.

Grammarly was used to support spelling, grammar correction, and language proofreading during the writing process.

5 Activity design

This thesis does not report on a single prototype. Instead, it documents a series of activities that were designed, tested, and redesigned across six sessions. Each session was a design decision.

Before the main sessions began, I ran several pilot activities at a folkhögskola in Malmö. These were informal a way of getting smell into a social gathering and seeing what happened. I was not collecting data. I was learning how smell behaves when people are asked to talk about it together. Those pilots shaped almost every decision that followed.

The six main sessions took place across three folkhögskolor (Hyllie Park, Kvarnby, and Glokala). Each activity was designed for small groups and built around a simple condition, participants responded to a shared material a smell or an image while using a second language. Each condition ran for five minutes. That was enough time for interaction to develop, and short enough to compare conditions clearly. Participants interacted in small groups around a shared table setup (Figure 2). Smell was delivered using a paper method. Small amounts of scent were applied to paper strips and placed in front of participants, keeping the smell localized and manageable during the activity (Yanagida, 2012).

The progression across sessions was not planned. It emerged from what I observed. Session 1 started simple one familiar smell, one shared sentence. Session 2 opened the task into storytelling and introduced unfamiliar smells. Session 3 added game structure and competition. Session 4 dropped the competition and moved toward playfulness. Session 5 tested a structured turn taking rule with the same group. Session 6 introduced shifting roles and temporary inversions, producing something closer to carnivalesque interaction a concept I borrowed from Sicart (2014).

Each session was also a material exploration. I was not just designing tasks. I was observing how smell behaved differently depending on the group, the format, and the rules around it. Activity instructions, post activity interview questions, and supporting session materials are included in the Appendix.



Figure 2. Small group activity setup used during the interaction sessions

6 Design Process

6.1 Session 1, Hyllie Park Folkhögskola

The first session was the starting point of the design process. The aim was to turn the research idea into a simple activity that could be tested with participants. At this stage, the focus was not on producing results, but on creating a situation where participation could be observed through interaction.

6.1.1 Design Purpose

The starting question was simple, can smell work as an interaction material in a small group language activity? Orange was chosen because it is a familiar scent, which helped reduce uncertainty and let participants focus on the activity rather than the material itself. The one sentence format was kept short on purpose to make participation easy to track, who spoke first, who responded, and how the group arrived at a shared idea together.

6.1.2 Context and Setup

The activity was tested with a group of (5) participants. Participants were asked to describe a shared stimulus and create one sentence together.

6.1.3 Design Decisions

Orange was selected because it is easy to recognize and straightforward to introduce in a classroom setting. Smell was chosen as the starting stimulus because it is often difficult to put into words (Stevenson, 2010). Different participants tend to connect the same smell to different experiences, which can open discussion and interpretation within the group (Maggioni et al., 2019).

The activity followed a short, structured format, participants discussed the stimulus, then produced one shared sentence. A non smell condition was included using the same format but with a different type of input. This made it possible to compare how the two stimuli shaped participation while keeping the task structure consistent (Jordan & Henderson, 1995).

6.1.4 Control Condition

A non smell condition using an abstract word was included alongside the smell condition. The activity structure stayed the same across both the only difference was the stimulus. This comparison was useful for observing how different types of input shaped participation. Different forms of stimuli can support different ways of engaging with information (Mayer, 2009). Visual and verbal materials also tend to activate different cognitive pathways during interaction (Paivio, 1986).

6.1.5 Design Reflection

The session produced a working first version of the activity. The simple structure made it possible to track who initiated talk, who responded, and how participants built toward a shared sentence. At the same time, the one sentence format limited how much interaction could develop participants could offer a short idea without needing to build on what others said.

This pointed toward a need for a more open format. Session 2 shifted the activity to collaborative storytelling and introduced smell familiarity as a new design element, following the iterative logic of a Research through Design approach (Vaughan, 2017).

6.2 Session 2, Kvarnby Folkhögskola

The second session was developed as an iteration of the first activity. Based on observations from the initial session, the aim was to redesign the activity to support more connected interaction between participants.

6.2.1 Design Purpose

This session made two design changes in response to what Session 1 revealed. First, the single sentence task was replaced with collaborative storytelling to encourage more connected interaction between participants. Storytelling creates a shared space where participants build on each other's ideas (Bruner, 1991). It also supports the development of meaning through dialogue and joint participation (Mercer, 2000).

Second, smell familiarity was introduced as a design element using one familiar and one unfamiliar smell. This addressed the sub question of how familiar and unfamiliar smells influence participation and interaction. Familiar smells are generally easier to recognize and describe, while unfamiliar smells tend to encourage more interpretation and negotiation between participants (Stevenson, 2010).

6.2.2 Design Changes

In Session 1, participants produced one shared sentence together. Here, the task shifted to collaborative storytelling. Participants were asked to describe the smell and build a shared story by continuing each other's ideas. The change was introduced to encourage more connected interaction instead of short individual responses. Storytelling was selected because it creates a shared interaction space where participants respond to each other and develop ideas together (Bruner, 1991).

6.2.3 Familiarity as a Design Element

Instead of using one scent, two types of smells were introduced, one familiar and one unfamiliar. To support this decision, a small familiarity test was conducted before the activity to identify which scent samples participants experienced as familiar or unfamiliar. The purpose was to base smell selection on participant perception rather than personal assumptions.

The test was conducted at Malmö University with a small group of participants. Each participant smelled several scent samples and rated how familiar each felt using a 5 point scale:

- completely unfamiliar
- slightly unfamiliar
- neutral
- familiar
- very familiar

The tested scents included ginger, ylang ylang extra, liquorice (20%), petitgrain, and cedrat. Based on the ratings, cedrat was selected as the familiar smell and ylang ylang extra as the unfamiliar smell (Figure 3). This process grounded the smell selection in participant perception rather than assumption. Similar approaches are used in olfactory research when examining smell familiarity (Distel et al., 1999).

Previous research shows that familiarity influences how smells are interpreted and described. Familiar smells are generally easier to recognize, while unfamiliar smells require more interpretation and discussion (Stevenson, 2010). Ambiguous sensory materials can also shape how participants negotiate meaning together during interaction (Maggioni et al., 2019).

Scent Sample	Completely unfamiliar	Slightly unfamiliar	Neutral	Familiar	Very familiar
Scent 1	☐	☐	☐	☐	☐
Scent 2	☐	☐	☐	☐	☐
Scent 3	☐	☐	☐	☐	☐
Scent 4	☐	☐	☐	☐	☐
Scent 5	☐	☐	☐	☐	☐



Figure 3. Familiarity test and scent samples used to classify familiar and unfamiliar smells.

6.2.4 Control Condition

As in Session 1, a non smell condition using an abstract word was included to support comparison. The same storytelling structure was used across all conditions the only difference was the interaction material.

6.2.5 Design Reflection

This session introduced two changes, replacing the single sentence task with collaborative storytelling and adding smell familiarity as a design element. Together, these changes created a more open interaction structure where participants needed to build on each other's ideas rather than contribute separately.

Smell familiarity did influence participation. Familiar smells led to faster and more confident responses, while unfamiliar smells produced more hesitation, interpretation, and negotiation. However, participation remained uneven. Some participants contributed more frequently while others stayed less active, and collaborative building appeared less often than expected. The storytelling format alone was not enough to distribute participation equally across the group. Based on these observations, Session 3 introduced a game structure with rules and roles to create clearer conditions for all participants to contribute.

6.3 Session 3, Glokala Folkhögskola

The third session focused on developing the activity into a more game and dynamic structure. The aim was to explore how changes in rules, materials, and activity design could influence participation and communication between participants.

6.3.1 Design Purpose

Session 2 showed that the storytelling format alone did not distribute participation evenly across the group. This session explored whether a game structure could produce more equal and connected participation. Rules, roles, and competitive elements were introduced to create clearer conditions for all participants to contribute. Rules are known to shape how interaction unfolds during collaborative activities (Fullerton, 2014). Smell remained the central interaction material, used as an open and ambiguous prompt around which storytelling and game interaction were organised. Ambiguous sensory materials can encourage negotiation and shared meaning making between participants (Maggioni et al., 2019).

6.3.2 Brainstorming

Before developing the activity, brainstorming was used to explore different game formats and interaction structures (Figure, 4). Early ideas included simple smell guessing activities, but these were later rejected because they often produced short answers and limited discussion between participants. Instead, more open ended formats such as collaborative storytelling were selected to support interpretation, discussion, and shared meaning making.

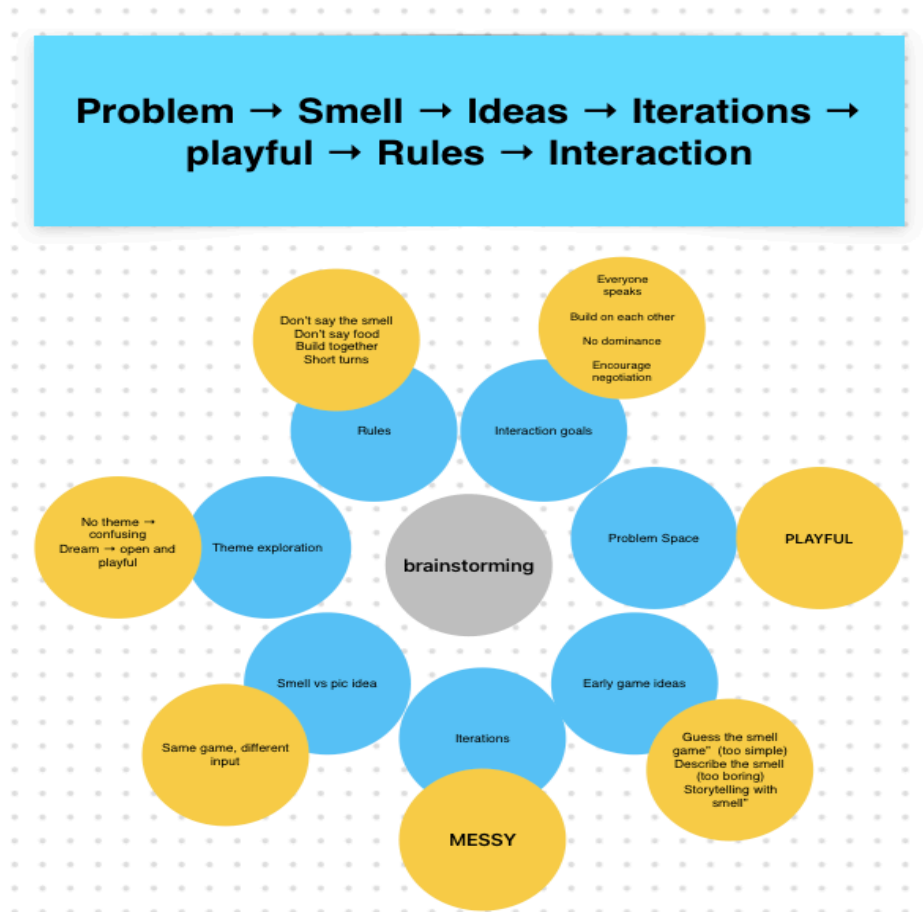


Figure 4. Early brainstorming process exploring different activity structures and interaction possibilities

6.3.3 Sketching and Design Development

Sketching was used to develop the game structure before testing it with participants. The sketches helped externalize ideas and examine different ways the activity could unfold (Buxton, 2007). They also supported reflection on design alternatives during development (Goldschmidt, 1991).

In the sketches, smell was positioned as the central material around which communication and storytelling were organised. The activity was designed to move from smelling, to interpretation, to discussion, and finally to shared story building (Figure 5). The sketches also helped visualize how the same smell could produce different interpretations between participants supporting the idea that smell could encourage negotiation and collaborative storytelling.

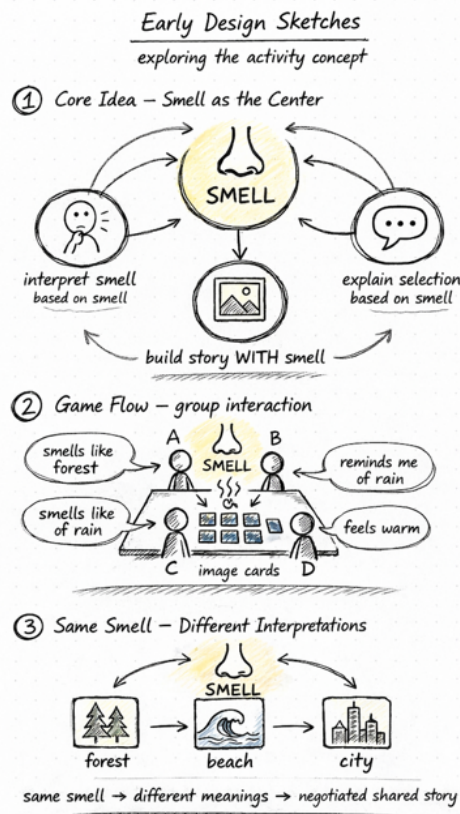
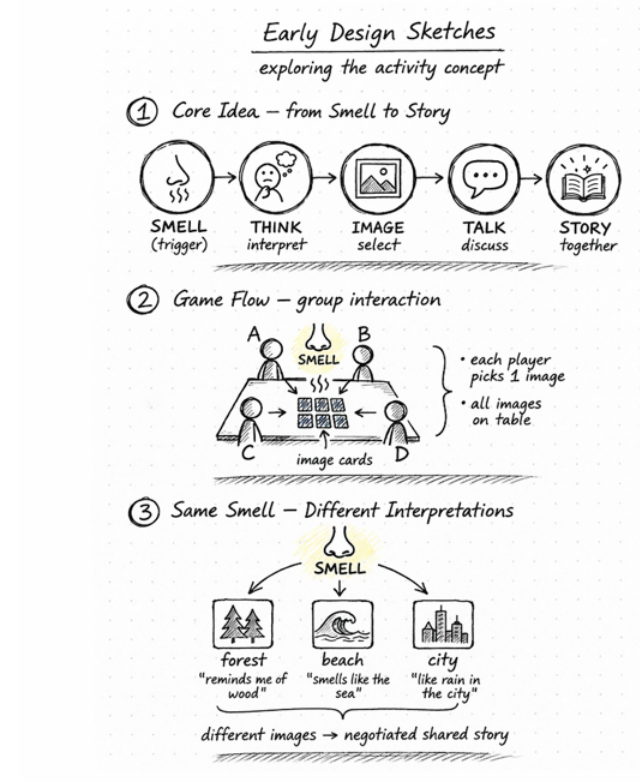


Figure 5. Early sketches showing the development of the activity flow from smell interpretation to collaborative storytelling.

6.3.4 MDA to Structure the Activity

Elements from the MDA framework informed parts of the game design (Hunicke et al., 2004). The framework was not used as a formal analytical method, but as a way of thinking about how rules and materials could shape interaction. The design process mainly focused on dynamics how participation emerged through responses, turn taking, and collaborative story building (Figure 6). Based on this, simple mechanics were introduced smelling the scent, selecting images, and contributing to a shared narrative.



Figure 6. MDA inspired activity structure with a focus on interaction dynamics.

6.3.5 Game Dynamics Structure

The activity developed into a collaborative storytelling game with rules and participant roles. Participants were asked to create a shared story based on a dream theme, where each contributed elements such as a character, place, or event. Instead of producing isolated answers, participants needed to continue and adapt previous contributions as the story developed. This supported a more connected form of participation, where meaning emerged through dialogue and shared storytelling (Gibbons, 2010). Building on each other's contributions also supports developing ideas together during group interaction (Swain, 2000).

The activity structure encouraged participants to collaboratively build a shared story through connected contributions (Figure 7).

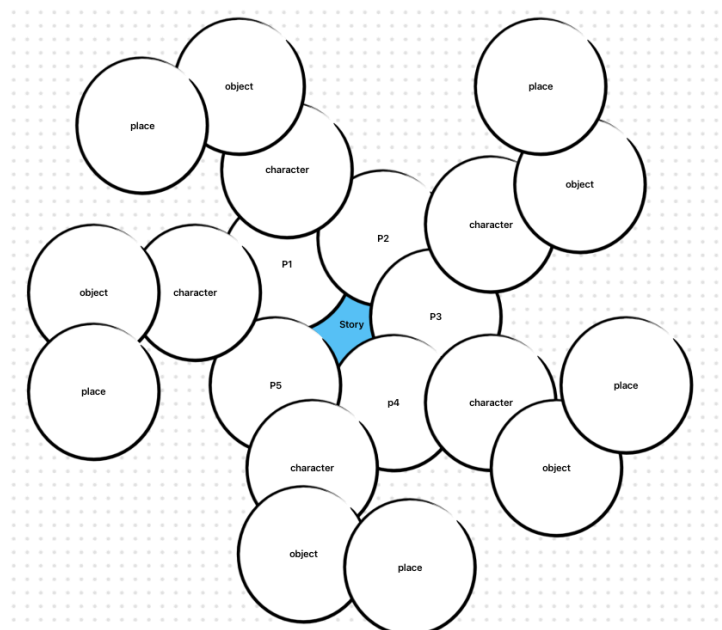


Figure 7. Collaborative storytelling structure showing how participants contributed characters, places, and objects to a shared narrative.

6.3.6 Introducing Rule Change

A rule change was introduced during the activity to disrupt the ongoing story structure. At one point, participants were asked to reinterpret the meaning of the smell and continue the story from a different perspective. This required participants to adapt earlier ideas and reinterpret the narrative together. The goal was to introduce uncertainty and encourage new forms of interaction through reinterpretation. This connects to the concept of appropriation, where participants reshape and reuse elements of an activity in unexpected ways (Salen & Zimmerman, 2004).

6.3.7 Smell Choice and Use of Images

Cinnamon as smell was selected because it is a familiar and recognizable smell that can trigger associations and discussion. Research shows that cinnamon may influence attention and cognitive alertness (Zoladz & Raudenbush, 2005). In this study, however, the smell was not used to measure cognitive performance it was used as an interaction material that participants could interpret and discuss together.

Smell and images had different roles within the activity. The smell functioned as an open and ambiguous stimulus that encouraged interpretation and imagination. Because smells do not carry one meaning, participants needed to negotiate and explain their interpretations together (Majid & Burenhult, 2014). The images (Figure 7) acted as a supporting structure providing a visual reference that helped participants begin speaking and maintain the flow of the activity. Visual materials support language production and collaborative discussion by giving participants shared reference points (Gibbons, 2010).



Figure 8. Example image cards used to support interpretation, discussion, and storytelling during the activity.

6.3.8 Rules

The rules were designed to guide participation while still allowing multiple interpretations. Rather than producing correct answers, participants were encouraged to respond to each other and develop ideas together. Rules shape how interaction unfolds during activities (Fullerton, 2014). At the same time, the rules remained flexible enough to support playful exploration and reinterpretation (Sicart, 2014).

6.3.9 Design Reflection

The game structure increased speaking activity during the session. However, the competitive elements also produced unintended effects. Participants focused more on introducing their own contributions rather than building on each other's ideas, which made interaction more fragmented and less collaborative. One participant frequently controlled the storytelling flow, while others contributed less or went silent during parts of the activity. The competitive structure increased individual activity but reduced shared story development across the group. Based on these observations, Session 4 moved away from competition and toward a more playful interaction structure.

6.4 Session 4, Kvarnby Folkhögskola

6.4.1 Design Purpose

This session explored whether removing competitive elements could produce more equal and collaborative participation. Playfulness was introduced as a design approach not as fun or entertainment, but as a way of engaging with the activity without pressure to produce correct answers. As Sicart (2014) argues, playfulness “*preserves the purpose of the activity it is applied to*” while opening space for personal expression and reinterpretation.

6.4.2 Design Change: From Competition to Playfulness

Instead of organizing the session around performance or winning, the focus shifted toward a more open interaction space. This moved the interaction away from correct answers and toward shared exploration and collaborative storytelling a shift from structure participation toward what Sicart (2014) describes as “*pleasurable or emotionally engaging*” interaction (Figure 9).

Scent = trigger
Appropriation = mechanic
Interaction = result

Figure 9. Relationship between smell, appropriation, and collaborative interaction in the activity design.

6.4.3 Playfulness as Design Approach

The activity was redesigned to support more playful participation. Participants could interpret the smell in different ways, respond with imaginative ideas, and change or build on previous contributions during the interaction. This draws on the concept of appropriation from Sicart (2014), who argues that playfulness means bringing a free and expressive attitude into activities that were not originally designed for play. In this session, participants were not playing a game, they were approaching a language activity in a playful way.

Sicart (2014) also shows that playfulness makes a situation more open to personal interpretation. This connected directly to how smell worked in the activity, as an open material with no single correct meaning, which participants could explore and describe in their own way (Figure 10).

6.4.4 Smell and Image Materials

Garlic and mint were selected because they are strong and easily recognizable smells with different associations. This contrast was used to create variation in how participants described and interpreted the sensory material. The smells functioned as ambiguous prompts that encouraged discussion and personal interpretation rather than direct identification. Smell perception is closely connected to memory and personal experience (Herz, 2004). This connection influences how participants describe and negotiate meaning around a shared sensory stimulus (Distel et al., 1999).

Image cards were introduced as supporting materials to help participants begin speaking and organize their thoughts. The images were intentionally open ended and not directly connected to the smells, allowing multiple interpretations and avoiding direct answers. Visual materials support language production and collaborative discussion by providing participants with shared reference points (Gibbons, 2010).

(Figure 10) illustrates how smell and reinterpretation were used to structure the activity during Session 4. Instead of treating the smell as a clear meaning, participants continuously reshaped and reinterpreted it throughout the storytelling process. The activity encouraged participants to transform previous ideas, respond to each other, and collaboratively build the narrative together. Introducing a new smell during the activity also disrupted the existing story and encouraged participants to reinterpret the situation again through playful interaction.

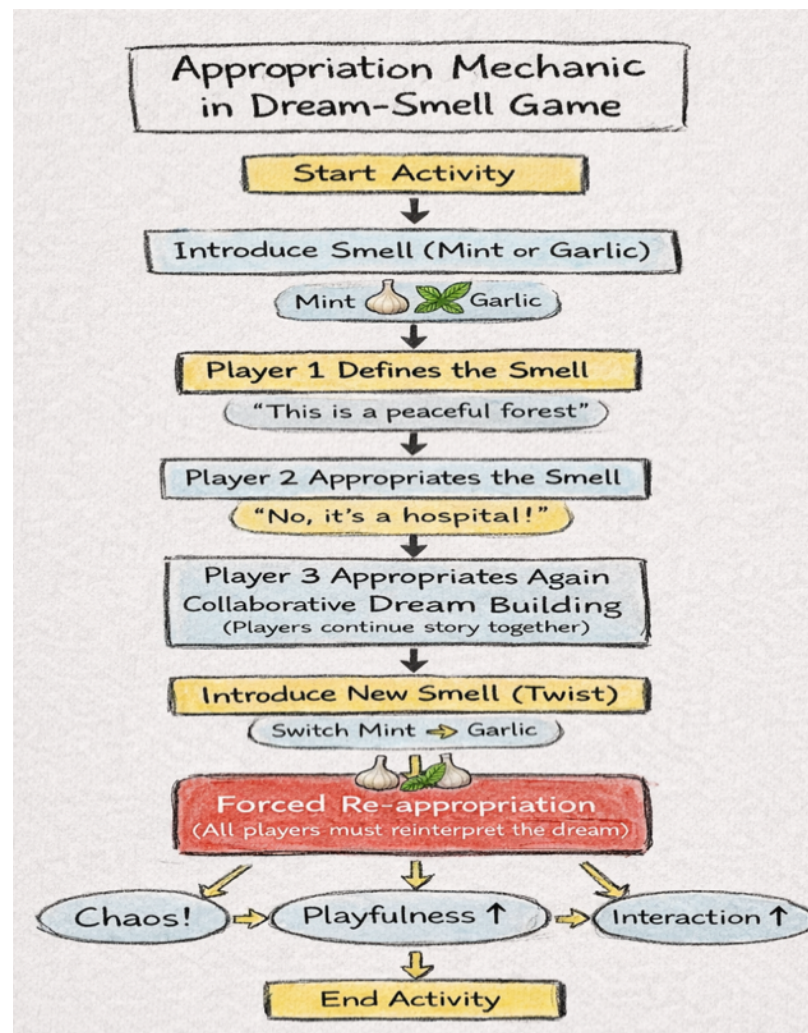


Figure 10. Appropriation mechanic supporting reinterpretation and collaborative storytelling during the activity

6.4.5 Smell as Experienced by Participants

Short post activity interviews were conducted to understand how participants experienced the smell during the session. The interviews focused on how the smell influenced imagination, interpretation, and interaction throughout the activity. The full list of interview questions is included in the (Appendix 12.2).

6.4.6 Design Reflection

This session changed things. Instead of trying to perform or compete, participants just played and participated more freely. Contributions became harder to define, and interaction developed through reinterpretation, imagination, and collaborative exploration rather than competition. Playful structures reduced pressure related to correctness, which made participation feel more open across the group. At the same time, contributions were sometimes exploratory but disconnected from each other. Playfulness alone did not always produce connected participation. Session 5 introduced a structured turn taking rule to address this requiring each participant to continue directly from the previous contribution before adding a new idea.

6.5 Session 5, Kvarnby Folkhögskola

Session 4 allowed more open interaction, but contributions were sometimes exploratory and disconnected from each other. Playfulness alone did not always produce connected participation. This session continued with the same group of four participants to allow a more direct comparison between iterations.

6.5.1 Design Purpose

A structured turn taking rule was introduced to strengthen collaborative participation. A continuation rule was added, requiring each participant to build directly on the previous contribution before adding a new idea. This was intended to create stronger connections between turns and reduce individual dominance during the activity. Participation emerges through coordinated social action rather than isolated contributions (Goodwin & Heritage, 1990). Building on shared ideas supports collaborative meaning making during group interaction (Mercer, 2000).

6.5.2 Design Change: Structured Turn Taking

When one participant introduced a character, object, or event, the next participant was required to continue the story using that contribution before adding a new element. This created a direct connection between turns. Instead of producing separate responses, participants needed to respond to and extend previous contributions as the narrative developed. The rule was designed to encourage more continuous interaction and reduce isolated individual responses.

6.5.3 Design Reflection

The structured continuation rule created a more connected interaction flow compared to the previous session. Participants relied more directly on each other's contributions. The activity became less fragmented, and storytelling developed through ongoing responses rather than separate individual ideas. Using the same participants also strengthened the iterative comparison between sessions making it easier to observe how participation changed because of the modified rule structure rather than differences between groups. These observations informed Session 6, where the design explored more dynamic and unpredictable forms of participation through shifting rules and temporary role changes.

6.6 Session 6, Hyllie Park Folkhögskola

Session 5 showed that a static continuation rule produced more connected participation but made interaction predictable. This session explored a different approach drawing on the concept of carnivalesque interaction, where roles and norms are temporarily inverted to create uncertainty and spontaneity (Sicart, 2014). The goal was to observe whether shifting rules and temporary role changes could encourage more dynamic and unexpected forms of participation across the group.

6.6.1 Design Purpose

The purpose was to explore how shifting rules and temporary disruptions could influence participation and collaborative interaction. Unlike Session 5, which focused on structured turn taking, this design introduced a more unpredictable interaction flow. Participants needed to continuously decide when to speak, when to remain silent, and how to respond to changing rules. This created a balance between structure and spontaneity, where rules guided participation while interaction remained open to reinterpretation. Sawyer (2004) describes this as disciplined improvisation structured activities that still allow unpredictability and adaptation. The design also explored how playful rule breaking could shape communication and participation (Sicart, 2014).

6.6.2 Design Change: Introducing Carnivalesque Interaction

The Simon Says format was selected because it is a familiar children's game with simple but socially engaging rules. The activity was redesigned using a modified "Simon Says" structure. Participants were only allowed to speak when an instruction included the phrase "Simon says." If someone spoke without the instruction, their contribution was ignored and they lost the opportunity to later take the role of "Simon."

This rule created moments of uncertainty and required participants to continuously pay attention to timing and interaction flow. At the same time, the role of "Simon" was not stable, different participants could take over the role during the activity, allowing temporary shifts in control and participation. Rules shape how interaction unfolds during games and collaborative activities (Fullerton, 2014). Allowing the role of "Simon" to move between participants created a more flexible interaction structure where authority and conversational space shifted continuously during the session. Participation emerges through coordinated actions between participants rather than static speaking roles (Goodwin & Heritage, 1990).

6.6.3 Smell and Image Materials

The Mint was selected as the smell stimulus because it is familiar but still open to multiple interpretations. Participants could associate the smell with different contexts such as food, gum, medicine, or freshness. This variation supported discussion and interpretive responses during the activity (Distel et al., 1999). The difficulty of fixing a single meaning to mint also encouraged participants to negotiate interpretations together (Majid & Burenhult, 2014). The same interaction structure was used in both smell and picture conditions to support comparison between modalities (Jordan & Henderson, 1995).

6.6.4 Design Reflection

Unlike Session 5, where turn taking followed a clear and predictable sequence, the Simon Says format created uncertainty. Participants needed to pay attention to timing, instructions, and each other before deciding when to speak. The shifting role of Simon changed how control worked within the group different participants temporarily took over the role during the activity, which created moments where authority and conversational space moved between people rather than staying fixed. The rule structure also produced hesitation and silence. Some participants were unsure whether they were allowed to speak, which created pauses during the activity.

Across all sessions, the design moved from simple and familiar toward more complex and unpredictable interaction structures. Each session built on the previous one and revealed something different about how smell, rules, and activity design shaped participation in small group second language settings.

7 Results

All sessions were documented through video and audio recordings. The recordings were reviewed and analysed using the participation categories described in the method section. Interaction data was first organised into tables and then converted into diagrams to support comparison across sessions and conditions.

7.1 Session 1, Hyllie Park Folkhögskola

This session compared a word condition with a familiar smell condition (orange) in a small group activity. Participation was analysed through initiation (I), response (R), collaborative building (CB), and withdrawal (W).

7.1.1 Word Condition

In the word condition, interaction followed a relatively direct pattern. Most contributions appeared as individual initiations followed by short responses. Collaborative building appeared only occasionally, and participants often introduced separate ideas instead of continuing previous contributions. Some participants contributed frequently throughout the activity, while others participated less or remained silent for longer periods.

7.1.2 Familiar Smell (orange)

In the smell condition, participants produced more responses and collaborative building compared to the word condition. Participants often reacted to each other's descriptions and expanded previous contributions during the discussion. Pauses and hesitation also appeared, particularly when participants searched for words to describe the smell. Although participation varied across the group, more participants contributed responses during the activity compared to the word condition.

7.1.3 Participation Distribution

Participation was distributed differently across the two conditions (Figure 11). In the word condition, most interaction came from a smaller number of participants. In the smell condition, responses and shared contributions appeared more frequently across the group. However, certain participants still contributed more frequently than others.

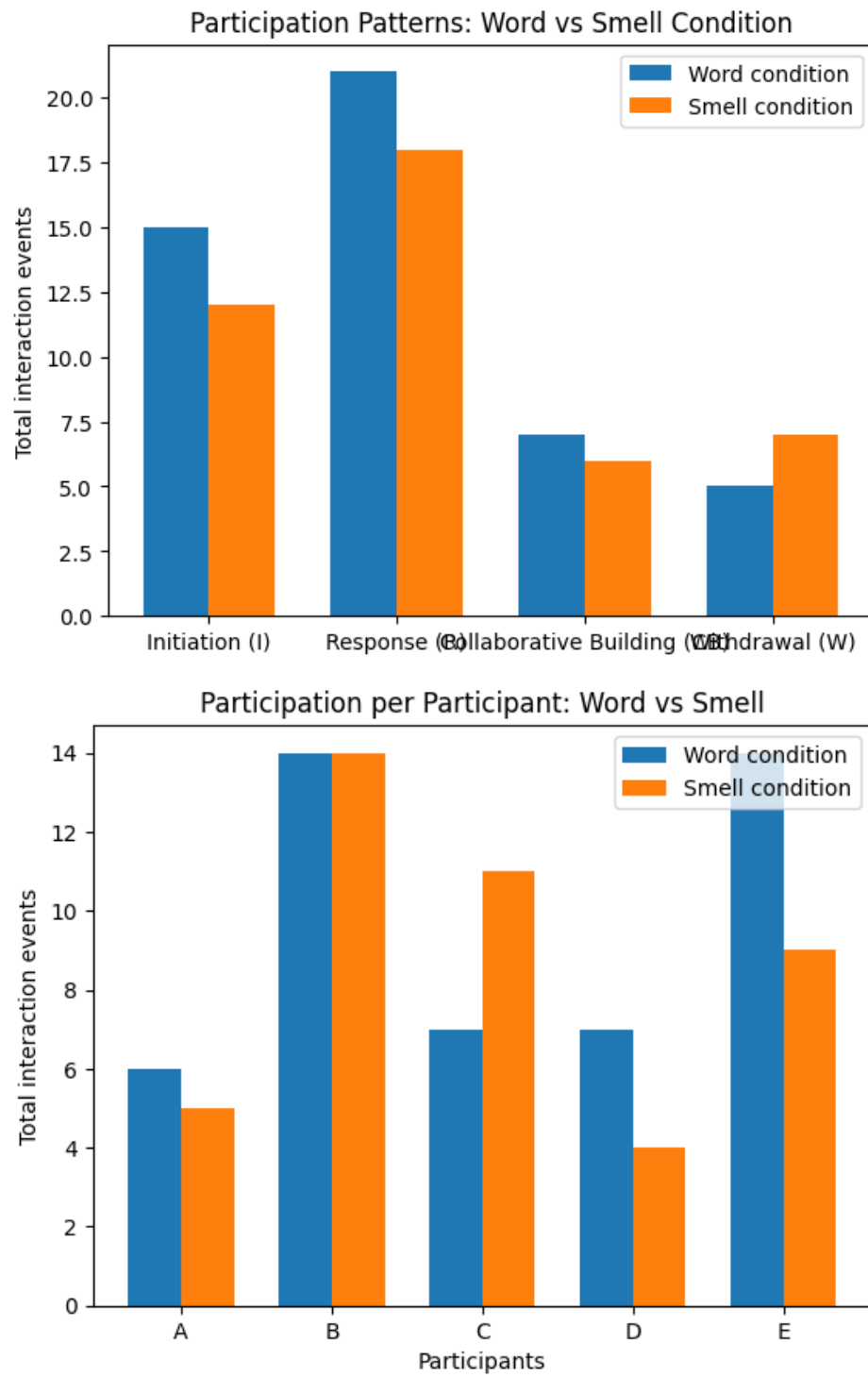


Figure 11. Participation patterns across word and smell conditions.and Distribution of participation across participants and conditions.

7.2 Session 2, Kvarnby Folkhögskola

This session included three conditions a word condition, a familiar smell condition (cedrat), and an unfamiliar smell condition (ylang ylang extra). The classification of the smells as familiar and unfamiliar was based on the familiarity test conducted before the activity.

7.2.1 Word Condition

In the word condition, interaction followed a relatively structured pattern. Most contributions appeared as individual initiations followed by short responses. Collaborative building appeared less frequently, and participants often introduced separate ideas rather than developing them together. Some participants contributed more frequently throughout the activity, while others showed longer moments of silence or withdrawal.

7.2.2 Familiar Smell (Cedrat)

In the familiar smell condition, responses and collaborative building appeared more frequently than in the word condition. Because the smell was more familiar to participants, responses often appeared more quickly, and participants more frequently continued each other's descriptions during the discussion. The interaction included several short sequences where participants expanded shared ideas together.

7.2.3 Unfamiliar Smell (Ylang extra)

In the unfamiliar smell condition, participants produced multiple and sometimes different interpretations of the smell. Because the smell was more difficult to recognize, participants often proposed different explanations and responded to each other's interpretations during the discussion. More hesitation and pauses appeared compared to the familiar smell condition. Participants sometimes waited before responding or looked at each other while searching for descriptions.

7.2.4 Participation Distribution

Participation was distributed differently across the three conditions (Figures 12 and 13). Some participants contributed more actively during the smell conditions, while others participated more frequently in the word condition. The familiar smell condition showed more continuous responses between participants, while the unfamiliar smell condition included both active discussion and longer moments of hesitation during the interaction.

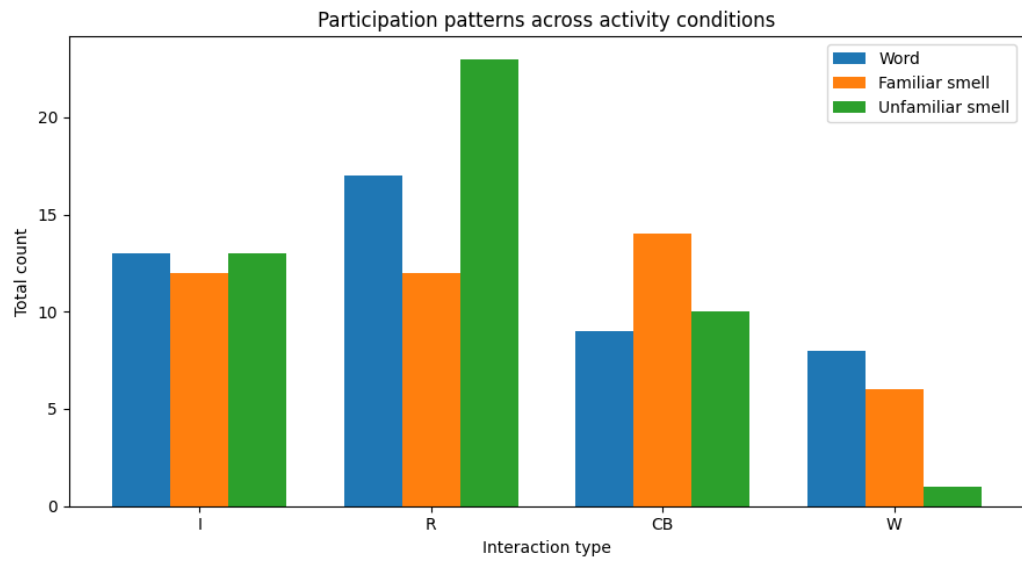


Figure 12. Participation patterns across word, familiar smell, and unfamiliar smell conditions.

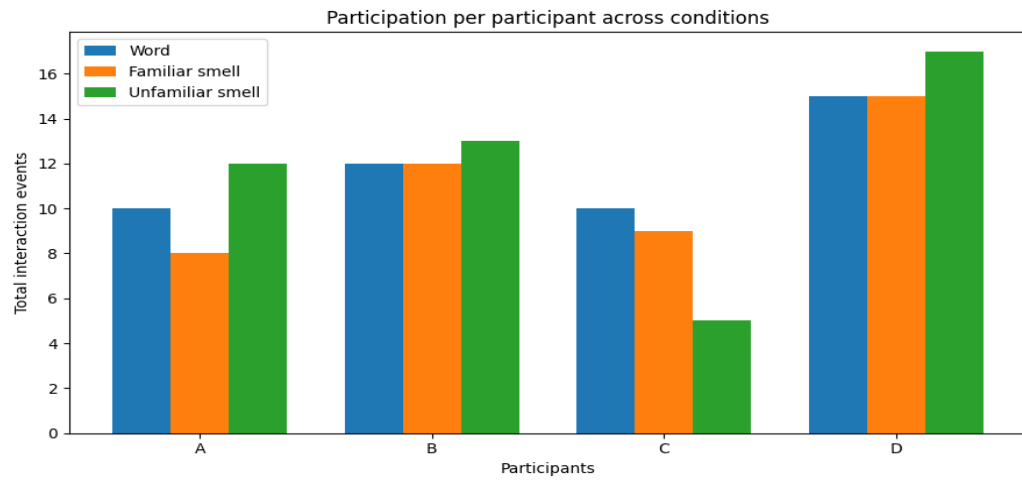


Figure 13. Distribution of participation across participants and conditions.

7.3 Session 3, Glokala Folkhögskola

This session tested a competitive game structure using smell as the main material. The goal was to see if rules and roles could help more participants contribute during the activity.

7.3.1 Smell Condition

Participants mostly introduced their own ideas rather than building on previous contributions. Responses and collaborative building appeared less frequently than in the previous sessions. One participant spoke more frequently than the others and often controlled the direction of the story. As the session continued, some participants contributed less and remained silent for longer periods. Participants more often introduced new ideas instead of continuing previous contributions during the activity.

7.3.2 Participation Distribution

Participation was distributed unevenly across the group. Some participants contributed frequently throughout the activity, while others participated less often. Initiation was the most common form of participation, while collaborative building appeared least frequently during the session.

7.4 Session 4, Kvarnby Folkhögskola

7.4.1 Smell Condition

In the smell condition, most contributions appeared as initiation. Participants frequently introduced new interpretations and associations, while collaborative building appeared less frequently. Participant A contributed most frequently during the session, while participant C was the only participant who showed all four participation categories, initiation, response, collaborative building, and withdrawal. One moment of withdrawal was observed during the activity. Participants often introduced separate interpretations rather than continuing previous contributions.

7.4.2 Picture Condition

In the picture condition, initiation also appeared frequently, but collaborative building occurred more often than in the smell condition. Participants more regularly continued and expanded each other's ideas during the storytelling process. Both participant A and participant B contributed repeatedly to collaborative building sequences. No withdrawal was observed in this condition. Compared to the smell condition, participants more frequently responded to and continued previous contributions during the activity.

7.4.3 Participation Distribution

Participation was distributed differently across the two conditions (Figure 14). In the smell condition, participants more often introduced separate interpretations and individual associations. In the picture condition, participants more frequently continued and expanded each other's contributions during the storytelling activity.

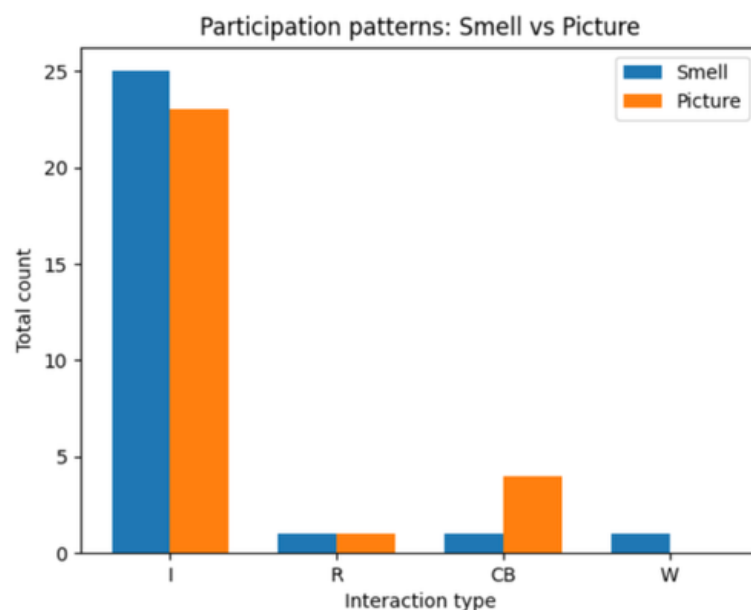


Figure 14. Participation patterns across smell and picture conditions.

7.4.4 Interview Results

The interview responses showed differences in how participants experienced the smell and picture conditions. Several participants described the smell condition as more personal and open ended. Some participants explained that the smell triggered memories and individual associations during the activity. One participant described the experience as:

“An inner monologue outside.”

Participants also described the smell condition as producing different interpretations between participants during the storytelling process. In contrast, the picture condition was described as clearer and easier to continue collaboratively. Participants explained that the images provided a more stable reference point during the activity. Several participants described the storytelling in the picture condition as easier to follow and continue together.

7.5 Session 5, Kvarnby Folkhögskola

This session compared a smell condition with a picture condition using the structured turn taking rule introduced during the design process.

7.5.1 Smell Condition

In the smell condition, responses and collaborative building appeared more frequently than initiation. Participants often continued and expanded previous contributions rather than introducing completely new ideas. The storytelling developed through connected responses between participants. Withdrawal appeared only occasionally, and most participants remained active throughout the activity. Participants more frequently responded directly to previous contributions compared to earlier sessions.

7.5.2 Picture Condition

In the picture condition, both initiation and response appeared frequently during the activity. Participants introduced new ideas while also continuing previous contributions. Collaborative building appeared regularly, although the storytelling shifted more often between individual contributions and shared development compared to the smell condition. Participation remained active throughout the session, although some participants contributed more frequently than others. A small number of withdrawal moments also appeared during the activity.

7.5.3 Participation Distribution

Participation differed between the two conditions (Figures 15 and 16).

In the smell condition, contributions were more evenly distributed across participants, mainly through responses and collaborative building.

In the picture condition, participation was less balanced, with certain participants contributing more frequently than others. The picture condition also included more initiation and slightly more withdrawal.

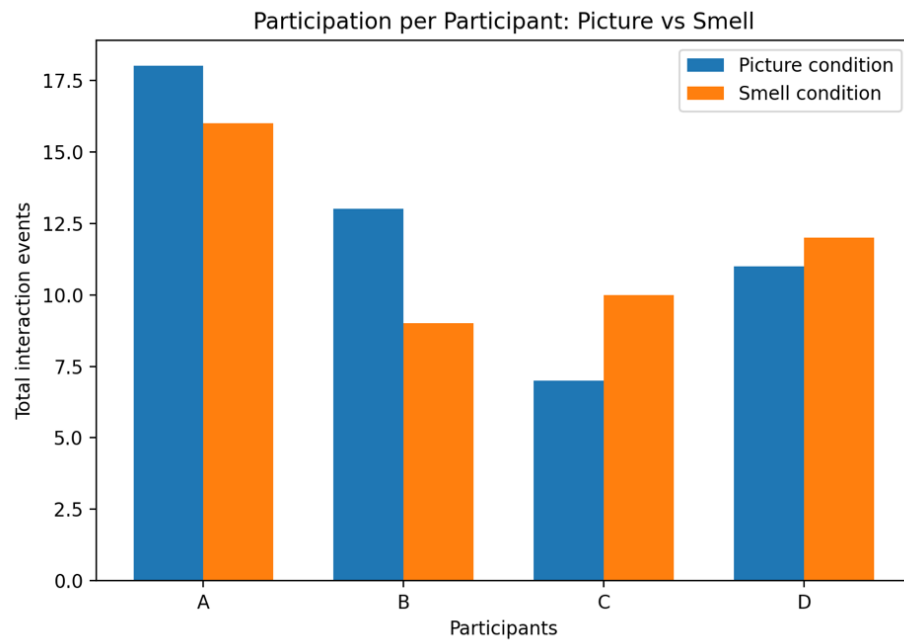


Figure 15. Participation patterns across smell and picture conditions.

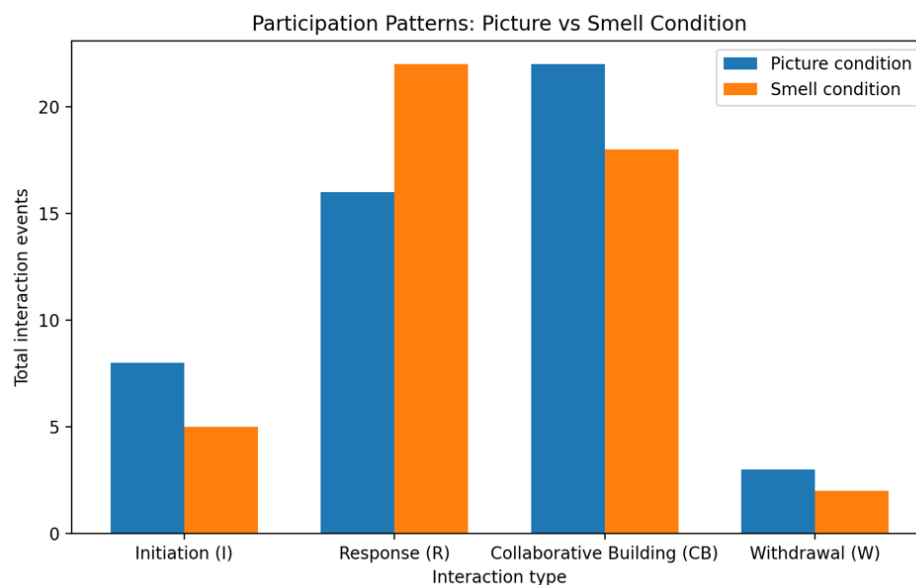


Figure 16. Distribution of participation across participants and conditions.

7.5.4 Interview Results

The interview responses showed that the structured turn taking rule influenced how participants interacted during the activity.

Several participants described the storytelling as more connected because they needed to continue each other's contributions. One participant explained that they were:

“Piggybacking on each other's thoughts and theories.”

Participants also described the interaction as easier to follow compared to earlier sessions. Some explained that the activity flow became clearer, which made participation feel more natural during the storytelling process.

At the same time, a few participants described moments where they intentionally tried to interrupt or redirect the flow of the story, showing that the interaction remained flexible despite the structured rule system.

7.6 Session 6, Hyllie Park Folkhögskola

This session compared a smell condition (mint) with a picture condition using the same “Simon says” interaction structure, carnivalesque.

7.6.1 Smell Condition

In the smell condition, responses appeared more frequently than initiation. Participants often reacted to previous contributions instead of introducing completely new ideas. Participant C produced the highest number of responses during the activity.

Collaborative building also appeared several times, mainly through participants A and D, who repeatedly continued and expanded shared story elements.

Withdrawal appeared more frequently in this condition, particularly for participant B, who showed the highest number of withdrawal moments.

The activity included both connected storytelling sequences and moments of hesitation silence or participants paused before responding during the interaction.

7.6.2 Picture Condition

In the picture condition, responses again appeared most frequently, but initiation increased compared to the smell condition. Participant D produced the highest number of initiations during the session. Collaborative building remained present throughout the activity, while withdrawal appeared less often than in the smell condition. Two participants showed no withdrawal during the picture activity. Participation also appeared more continuous across the group, with fewer pauses between contributions.

Compared to the smell condition, participants more often continued and connected each other's ideas during the storytelling process.

7.6.3 Participation Distribution

Participation differed across the two conditions (Figures 17 and 18).

In the smell condition:

- responses appeared frequently
- collaborative building occurred regularly
- hesitation and withdrawal appeared more often

In the picture condition:

- initiation increased
- withdrawal decreased
- storytelling continued more steadily between participants

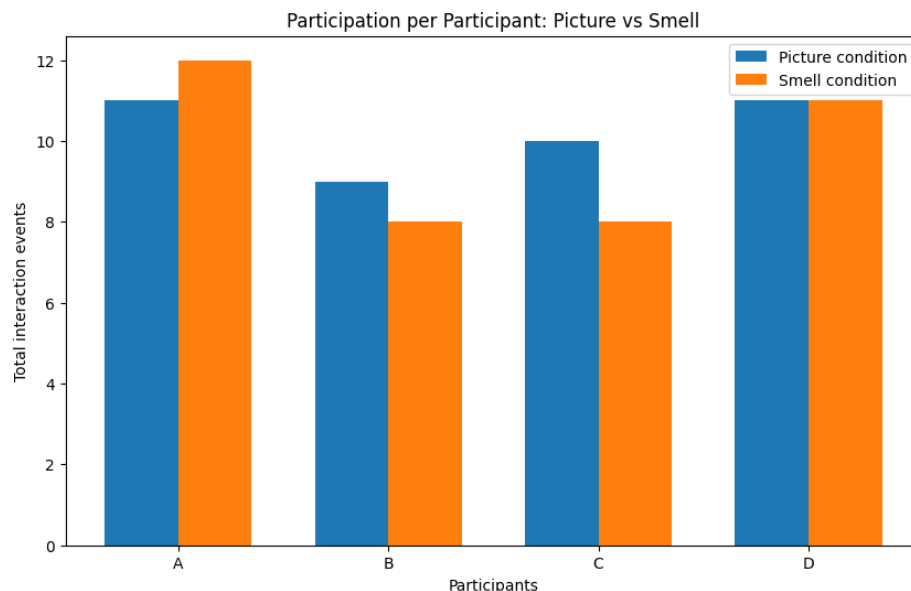


Figure 17. Distribution of participation across participants and conditions.

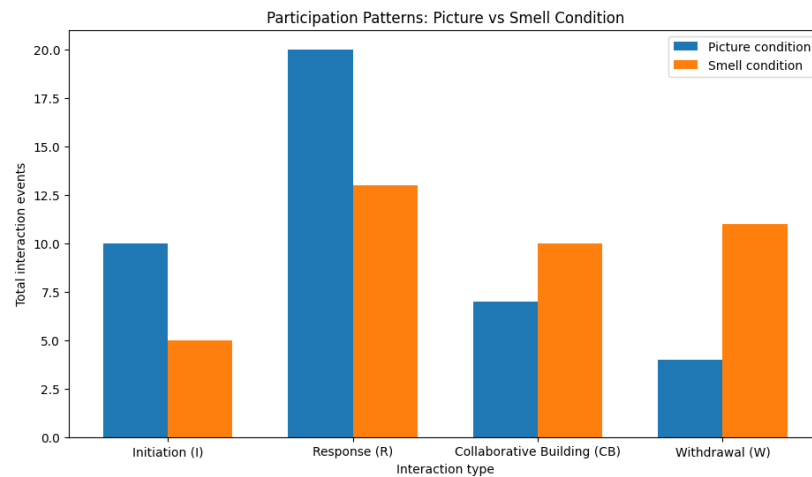


Figure 18. Participation patterns across smell and picture conditions.

7.6.4 Interview Results

Many participants described how the “Simon says” rule influenced when they were allowed to speak during the activity.

One participant explained: “It was a bit confusing... when Simon pointed at somebody... now you have to talk.”

Another participant described the activity as: “Stressing... because you point to one of us... now you have to talk.”

Participants also described moments where they were unsure whether they were allowed to speak during the activity.

One participant said: “It was funny... should we talk or should we not talk?”

Several participants described the picture condition as easier for collaborative storytelling.

One participant explained: “With the picture it was much better... the stories were coming together.”

In contrast, participants described the smell condition as producing more varied interpretations between participants: “The smell... it was a bit fuzzy, because we all have different thoughts.”

Participants also connected the mint smell to different personal associations and memories, including: “Christmas time.” “When I’m sick.” “Gum.”

Some participants explained that the smell was more difficult to use at the beginning of the activity compared to visual materials.

Participants also described how the activity structure influenced their participation.

One participant explained: “You have to talk more... maybe to go out from the comfort zone.”

Another participant described the pace of the interaction as:

“Think fast... don’t have time to think.”

8 Interaction Patterns

8.1 Participation Distribution

In the earlier sessions, participation was often unequal, with certain participants dominating the activity. In later sessions, structured continuation rules and collaborative storytelling supported more distributed participation across the group. Participants noticed this shift themselves. One described feeling pushed to engage: *"You have to talk more... maybe to go out from the comfort zone."*

8.2 Turn Taking Behaviour

Turn taking changed across the sessions. In the earlier activities, participants often introduced separate ideas without directly continuing previous contributions. Later sessions introduced rules that required participants to respond to and continue each other's ideas, creating more connected interaction sequences. Participants described this shift directly. One explained they felt like they were *"piggybacking on each other's thoughts and theories"* while another captured the pace: *"Think fast... don't have time to think"*.

8.3 Collaborative Dynamics

Collaborative building appeared more frequently in the later storytelling activities than in the earlier sessions. In the competitive activity, participants more often focused on introducing individual ideas. In later sessions, participants more frequently expanded and continued shared story elements together. One participant described the smell condition as feeling like *"an inner monologue outside,"* capturing how smell prompted personal interpretation that then became shared through interaction.

8.4 Withdrawal and Silence

Withdrawal and silence appeared across all sessions but occurred in different ways. In several smell conditions, participants paused before responding while searching for descriptions or interpretations. In Session 6, silence also appeared when participants waited for permission to speak during the "Simon says" activity. This uncertainty was reflected in how participants described the experience: *"It was funny... should we talk or should we not talk?"* in the moment, silence was often active hesitation rather than disengagement.

8.5 Differences Between Conditions

The smell and picture, word conditions produced different interaction patterns across the sessions. Picture conditions generally supported more continuous storytelling and connected responses between participants. Smell conditions produced more varied interpretations, exploratory discussion, and negotiation between participants. Participants described this contrast clearly. One explained: "*With the picture it was much better... the stories were coming together.*" Another captured what made smell different: "*The smell... it was a bit fuzzy, because we all have different thoughts*".

9 Discussion

9.1 Smell as Interaction Material

The activities showed how smell functions as an interaction material in small group second language activities. Rather than using smell to improve learning outcomes or language performance, the study examined how smell shaped participation, communication, and collaborative interaction between participants. The material exploration process also shaped this understanding. Smell was not applied as a ready tool. It was tested and observed across sessions to discover how it behaved in group interaction. Properties like ambiguity and hesitation were not predicted they emerged through the exploration itself (Wiberg, 2013).

Across the sessions, smell functioned differently from visual and verbal materials. Unlike words or images, smell did not provide a fixed or clearly shared meaning. Participants often interpreted the same smell differently and relied on discussion, association, and negotiation to describe their experiences. This was visible in how participants described the smell conditions. One captured it directly: *"The smell... it was a bit fuzzy, because we all have different thoughts."* Another described the experience as feeling like *"an inner monologue outside"* personal interpretation that only became meaningful through shared interaction. Majid and Burenhult (2014) showed that some languages have richer olfactory vocabularies than others, which suggests that the difficulty participants experienced in describing smells was not purely sensory, it was also shaped by the linguistic resources available to them in English as a second language. This adds another layer to Stevenson's (2010) discussion. In these sessions, the difficulty of describing smell was likely shaped not only by the ambiguity of smell itself, but also by participants interacting in a language that was not their mother language.

The results also align with research in multisensory interaction design showing that sensory materials influence engagement and social interaction rather than directly improving performance or learning outcomes (Maggioni et al., 2019; Løkken et al., 2025). In this study, smell shaped how interaction developed by influencing hesitation, responses, turn taking, and collaborative meaning making.

Basically, smell did not simply increase participation. Instead, it changed the form of participation. In several sessions, smell encouraged exploratory interaction where participants negotiated meaning together and responded to each other's interpretations. At the same time, smell also created hesitation and moments of silence when participants struggled to describe sensory experiences verbally.

These findings show that smell should not be understood only as an atmospheric or background element within interaction. Instead, it can function as an active interaction material that shapes communication and social dynamics during collaborative activities.

9.2 How Smell Shapes Participation

In the earlier sessions, interaction was often dominated by initiation, where participants introduced separate ideas without strongly developing each other's contributions. As the design process evolved, later sessions introduced more collaborative structures, including storytelling, reinterpretation, structured continuation rules, and playful interaction mechanics. These changes supported more response and increased collaborative building between participants.

Smell frequently encouraged participants to interpret and negotiate meaning together because the sensory input was harder to define than words or images. This sometimes created more responses and collaborative discussion. However, smell could also slow the interaction when participants hesitated or searched for vocabulary. Participants described this tension themselves. One explained: *"You have to talk more... maybe to go out from the comfort zone."* Another captured the pressure of the pace: *"Think fast... don't have time to think."*

Ambiguity appeared to influence participation in several ways during the activities. Because smell did not immediately provide a clear meaning, participants needed to actively construct meaning together through interaction. This supports perspectives where participation emerges through coordinated social activity rather than individual performance (Goodwin & Heritage, 1990).

At the same time, participation was strongly influenced by rules and interaction structures. For example, the structured continuation rule in Session 5 increased collaborative building because participants were required to continue previous ideas. Similarly, the "Simon says" rule in Session 6 shaped when participants could speak and introduced new forms of timing, silence, and responsiveness.

Goodwin and Heritage (1990) define participation as organized through moment by moment social interaction. What the sessions showed, however, is that this organization was not motivated by the smell alone it depended equally on the rules surrounding it. In Session 3, the smell was the same kind of ambiguous material as in other sessions, but the competitive structure redirected participation toward individual performance rather than shared exploration. This shows that sensory material does not carry meaning or social function on its own. Smell changed interaction differently depending on the rules and activity design. Fullerton (2014) argues that rules do not only

limit behaviour, but they also shape how interaction develops. In this study, smell functioned differently depending on the rules surrounding the activity.

In Session 4, pictures produced more collaborative building than smell. Pictures gave participants a clear shared reference, which made it easier to continue each other's ideas (Mayer, 2009). Smell produced more individual interpretations because participants connected it to different personal memories (Herz, 2004), which sometimes made shared storytelling harder. But this does not mean pictures worked better. Smell created more negotiation between participants (Majid & Burenhult, 2014). However, fluency does not necessarily mean deeper collaborative meaning making.

9.3 Ambiguity and Meaning Negotiation

One of the clearest findings across the study was the role of ambiguity in shaping interaction.

The smell conditions often produced uncertainty because participants interpreted the sensory material differently. Unlike images or words, smell did not automatically provide a shared meaning. Participants therefore needed to negotiate interpretations through discussion, responses, and collaborative exploration.

This ambiguity sometimes supported interaction by encouraging participants to compare interpretations, expand on each other's ideas, and develop meaning together. This was especially visible in the unfamiliar smell conditions, where participants relied more on negotiation and interpretation than in the word or picture conditions.

However, ambiguity also created challenges. In some sessions, participants hesitated before speaking or struggled to find words for their sensory experiences. Moments of silence and withdrawal were therefore not always signs of disengagement (Yeh, 2019). Participants reflected this themselves. One said: *"It was funny... should we talk or should we not talk?"* showing that silence was often active uncertainty rather than withdrawal. Another described the smell as triggering different personal associations: *"Christmas time."* *"When I'm sick."* *"Gum."* each a different starting point that participants then had to negotiate together. Instead, they often reflected active interpretation and meaning negotiation.

Across the sessions, ambiguity sometimes opened discussion, but in other moments it interrupted the interaction flow. While too much ambiguity sometimes interrupted communication, moderate ambiguity often appeared to encourage discussion, imagination, and building ideas together. Sicart (2014) argues that play is most generative when it resists fixed outcomes. The smell conditions in this study behaved similarly they encouraged multiple

interpretations, which sometimes opened space for richer negotiation, and sometimes produced silence and disengagement.

The ambiguity was productive in Sessions 5 and 6, where the activity structure supported interpretation, but it worked against interaction in Session 3, where the rules demanded performance rather than exploration.

This shows that ambiguity alone is not a design quality it is only useful when the surrounding structure gives participants a reason to engage with it rather than avoid it. It is also worth noting that this ambiguity was not expected before the study began. It was discovered through material exploration through repeatedly testing how participants responded to smell in real interaction settings.

9.4 Implications for Interaction Design

This study contributes to Interaction Design by exploring smell not only as an atmospheric or emotional component, but as a material that actively shapes social interaction (Maggioni et al., 2019). Across the sessions, smell influenced how participants interpreted, negotiated, and responded to each other during collaborative activities.

Small rule changes noticeably changed how participants interacted during the activities. Structured turn taking supported collaborative building, while more playful and shifting rules introduced unpredictability and changing participation dynamics (Fullerton, 2014; Sicart, 2014). This highlights the importance of interaction structure in shaping participation during collaborative activities.

The iterative process across six sessions showed something that is difficult to pre plan in design, ambiguity needs scaffolding. When smell was introduced into a competitive or loosely structured activity, it often produced silence and withdrawal rather than exploration. When the same smell was placed inside a storytelling structure with clear turn taking rules, it supported more connected and collaborative participation. This has practical implications for multisensory interaction design. It is not enough to select an interesting sensory material. The interaction structure around it determines whether the material opens or closes participation.

Løkken et al. (2025) found that smell did not significantly improve learning outcomes in shared reading activities. A similar pattern appeared in this study. Smell did not directly increase participation. Instead, it changed the form of participation by introducing more interpretation, hesitation, and negotiation of meaning between participants. For designers working in educational or collaborative contexts, this distinction is important. Smell should not be understood as a tool for improving performance, but as a material that changes how people relate and respond to each other during

interaction. Participants themselves pointed to this distinction. One described the picture condition as easier for building together: "*With the picture it was much better... the stories were coming together.*" In contrast, the smell condition produced something different more personal, more uncertain, but also more negotiated. As one participant put it: "*The smell... it was a bit fuzzy, because we all have different thoughts.*"

Research through Design (Zimmerman et al., 2007) also proved well suited for this type of exploration because the knowledge emerged through the iterative design process itself. Each session produced different insights. Session 3 showed how competition reduced collaborative interaction, while Session 5 demonstrated how a small rule change could shift participation from individual responses toward collaborative storytelling. This kind of situated knowledge would have been difficult to reach through controlled hypothesis testing alone, which highlights the value of RtD for exploring participation and multisensory interaction.

The material exploration process also showed that sensory materials need to be tested before they can be designed with. Smell behaved differently across sessions, and these differences were only visible through repeated testing. This showed that exploring a material is not a preparation step it is part of the design knowledge itself.

The participants in this study were adult learners at folkhögskolor in Malmö, where second language use was connected to both communication and social participation. In this context, silence did not always represent disengagement. Sometimes it reflected interpretation, uncertainty, or active processing during interaction (Yeh, 2019). This shows that low pressure and playful interaction structures may be important when designing collaborative multisensory activities in similar educational or social contexts (Gibbons, 2010; Hall, 2020).

9.5 Limitations of the Study

First, the study involved a relatively small number of participants and sessions. The outcomes therefore cannot be generalized to all second language contexts or participant groups. Instead, the study provides an exploratory understanding of how smell may shape interaction in small group activities.

Second, the activities were relatively short and focused on limited interaction moments. Longer sessions may have produced different participation patterns or allowed participants more time to adapt to the smells and interaction rules.

Third, smell perception is highly subjective and influenced by personal memories, experiences, and cultural associations (Herz, 2004). Participants therefore interpreted the smells differently, which affected interaction in unpredictable ways.

Finally, the iterative Research through Design process meant that the activity changed across sessions. While this supported design exploration, it also made direct comparison between sessions more complex.

10 Conclusions

10.1 Key Findings

This thesis explored how smell functions as an interaction material in small group second language activities. Rather than focusing on learning outcomes or language performance, the study examined how smell shaped participation, communication, and collaborative interaction between participants.

The outcomes show that smell influenced interaction differently from visual and verbal materials. Smell often introduced ambiguity, uncertainty, and personal interpretation, which encouraged participants to negotiate meaning together. Compared to the word and picture conditions, the smell conditions frequently produced more exploratory interaction and a stronger reliance on responses and interpretation. At the same time, smell also created hesitation and moments of silence, particularly when participants struggled to describe sensory experiences verbally. These moments did not always represent disengagement but often reflected active interpretation and meaning negotiation.

The comparison between conditions also revealed that activity structure played a central role in how smell shaped participation. Iterative changes such as storytelling, structured continuation rules, and the 'Simon says' mechanic shaped how participants responded, took turns, and collaborated during the activities. Smell familiarity also shaped the form of participation. Familiar smells produced faster and more confident responses, while unfamiliar smells encouraged more hesitation, interpretation, and negotiation between participants.

The results tell us that smell does not simply increase participation. Instead, it changes how participation develops by reshaping interaction dynamics, interpretation, and developing ideas together.

10.2 Contribution to Interaction Design

This project contributes to Interaction Design by exploring smell as an active interaction material that shapes participation and collaborative interaction, rather than functioning only as atmosphere or immersion (Maggioni et al., 2019).

Across the sessions, smell introduced ambiguity and interpretation into the activities. This encouraged participants to negotiate meaning and respond to each other during the interaction (Majid & Burenhult, 2014). It also supported collaborative idea building between participants throughout the storytelling process (Mercer, 2000). At the same time, smell could produce hesitation and silence, particularly when the interaction structure did not support collaborative exploration (Goodwin & Heritage, 1990).

The iterative design process demonstrated that interaction structure strongly influenced how smell shaped participation. Structured continuation rules supported more connected storytelling and collaborative building (Fullerton, 2014). In contrast, competitive structures often reduced collaborative interaction and directed participation toward individual performance (Sicart, 2014).

The project also contributes methodological insights. A Research through Design approach provided a framework for this type of exploratory study, where knowledge is generated through design practice rather than hypothesis testing (Zimmerman et al., 2007). The iterative and reflective nature of the process meant that each session produced new understanding that directly shaped the next design decision (Vaughan, 2017).

Finally, the main contribution of this study is not that smell increases participation. It is that smell reshapes it. Smell changed how interaction developed it introduced ambiguity, hesitation, and negotiation between participants rather than simply producing more talk. For interaction design, this matters. The form of participation is as important as the amount.

10.3 Future Work

Future research could explore smell interaction in larger groups and across longer periods of time for sessions. More participants and repeated sessions may provide a deeper understanding of how interaction patterns develop over time.

Future studies could also examine:

- Different types of smells and levels of familiarity
- Combinations of smell with sound or touch
- How cultural background influences smell interpretation
- How smell interaction functions in digital or mixed reality environments

In addition, future work could explore how sensory ambiguity influences other forms of collaborative activity beyond second language interaction.

This project mainly focused on observable participation patterns. Future research could combine interaction analysis with more detailed linguistic analysis to examine how smell influences vocabulary use, conversational structure, or language development.

Finally, Smell has potential as a design material for creating playful, social, and exploratory forms of interaction. Future design research could continue exploring how sensory materials shape communication, collaboration, and shared experience.

11

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12 Appendix

12.1 Interview Q

Section 4

1. Can you describe what you remember most from the activity?
2. What stayed in your mind after the activity ended?
3. How did you experience starting the activity?
4. Can you describe how your ideas developed during the activity?
5. What role did the smell play for you while you were thinking or speaking?
6. Can you describe how the interaction between you and others unfolded?
7. What moments stood out to you during the activity?
8. How did you decide what to say or contribute?
9. Can you describe how the activity moved from one idea to another?
10. What differences, if any, did you notice compared to other similar activities you've done?

Insights:

11. How would you describe the smell you experienced?
12. What came to your mind when you noticed the smell?

Section 5

1. Did the rule change how you spoke with others, for example who started speaking or how you responded?
2. Did the rule make you build ideas together more, or did you still speak individually?

Section 6

1. Can you describe what you remember most from the activity?
2. How did you decide when to speak during the activity?
3. How did the "Simon says" rule affect when you spoke or stayed silent?
4. What happened when someone spoke without "Simon says"?
5. Did the rule change how you interacted with others?
6. Did you feel that ideas were built together, or more individual?
7. How did your ideas develop during the activity?
8. What role did the smell (mint) play while you were thinking or speaking?
9. Did the smell help you generate ideas, or make it harder?
10. What differences did you notice between this activity and other similar activities?

12.2 Familiar and unfamiliar test

Scent Sample	Completely unfamiliar	Slightly unfamiliar	Neutral	Familiar	Very familiar
Scent 1	☐	☒	☐	☐	☐
Scent 2	☐	☐	☐	☒	☐
Scent 3	☐	☐	☒	☐	☐
Scent 4	☐	☐	☒	☐	☐
Scent 5	☐	☐	☐	☐	☒

Scent Sample	Completely unfamiliar	Slightly unfamiliar	Neutral	Familiar	Very familiar
Scent 1	☐	☐	☐	☒	☐
Scent 2	☐	☒	☐	☐	☐
Scent 3	☐	☐	☒	☐	☐
Scent 4	☐	☐	☐	☒	☐
Scent 5	☐	☐	☐	☐	☒

Scent Sample	Completely unfamiliar	Slightly unfamiliar	Neutral	Familiar	Very familiar
Scent 1	☐	☒	☐	☐	☐
Scent 2	☒	☐	☐	☐	☐
Scent 3	☐	☐	☐	☒	☐
Scent 4	☐	☐	☐	☐	☐
Scent 5	☐	☐	☐	☐	☒

Scent Sample	Completely unfamiliar	Slightly unfamiliar	Neutral	Familiar	Very familiar
Scent 1	☐	☒	☐	☐	☐
Scent 2	☐	☐	☐	☐	☒
Scent 3	☐	☐	☒	☐	☐
Scent 4	☐	☐	☐	☒	☐
Scent 5	☐	☐	☐	☐	☒

Scent Sample	Completely unfamiliar	Slightly unfamiliar	Neutral	Familiar	Very familiar
Scent 1	☐	☐	☒	☐	☐
Scent 2	☐	☒	☐	☐	☐
Scent 3	☒	☐	☐	☐	☐
Scent 4	☒	☐	☐	☐	☐
Scent 5	☐	☐	☐	☒	☐

12.3 Tables (Initiation / Response / CB / Withdrawal)

Person	I	R	CB	W
A				
B				
C				
D				

12.4 Activity Instructions

12.4.1 Session 1

The activity followed a simple sequence:

1. Participants sat around a table in a small group.
2. The instructions were read in the same way for both conditions.
3. A stimulus was introduced, either a smell or a word.
4. Participants discussed and described the stimulus together.
5. The group created one shared sentence based on the discussion.

12.4.2 Session 2

Participants sat in small groups around a table.

1. A stimulus was introduced to the group, either a smell or a word. In the smell condition, both familiar and unfamiliar smells were used.
2. Participants were asked to describe the stimulus and build a short story together. Each participant continued the story by responding to the previous contribution.

12.4.3 Session 3

The game followed a collaborative storytelling structure:

1. Participants first smelled the scent.
2. Each participant selected one image related to their interpretation of the smell.
3. Participants explained their image choices to the group.
4. The group discussed similarities and differences between interpretations.
5. Participants created a shared story where the smell became part of the narrative.

12.4.4 Session 4

The structure of the session remained flexible and open ended:

1. Participants smelled the scent.
2. Each participant contributed an idea, such as a character, place, or event.
3. Participants were allowed to reinterpret or change previous contributions.
4. The story developed through shared and evolving interaction.
5. No correct answer or winner was defined.

12.4.5 Session 5

Participants sat in small groups around a table.

1. A stimulus was introduced, either a smell or an image.
2. Participants created a shared story together. One participant began by introducing a character, place, or event.
3. The next participant was required to continue the story using the previous contribution before adding a new element.

12.4.6 Session 6

Participants sat in small groups around a table. A mint scent was introduced and placed in front of the group.

1. The activity used a modified version of “Simon says.”
2. Participants could only speak when an instruction began with the phrase “Simon says.” If a participant spoke without the instruction, the contribution was ignored and the participant could not later take the role of “Simon.”
3. One participant acted as “Simon” and gave instructions related to the smell, such as describing, continuing, or changing the story. The role of “Simon” could shift between participants during the activity.

12.5

Consent Form



Participation Consent Form

Project title: Pre-test: Familiar and Unfamiliar Smell Identification	Date: 17, Mars, 2026
Study manager: Tarek Alexander Khnijer Your E-mail Tarek_khnijer@hotmail.com	Studying at Malmö University, Faculty of Culture and Society, S-205 06 Malmö Phone +46 40 665 70 00 Education: interaction design Level: third year
This short activity is part of a bachelor thesis project in Interaction Design at Malmö University. The purpose of this pre-test is to determine which smell samples are perceived as familiar or unfamiliar by participants. During the activity, participants will smell a small number of scent samples and rate how familiar each smell is to them. The activity will take approximately 3–5 minutes. Participation is completely voluntary, and participants may withdraw at any time without providing a reason. No personal data such as names will be collected, and the responses will be recorded anonymously and used only for research purposes in the thesis. Participants are advised not to take part if they have allergies, sensitivities to scents, or any condition that may be affected by smelling fragrance samples. By taking part in this activity, participants confirm that they understand the purpose of the test and agree that their responses may be used anonymously in the research.	
I hereby submit my consent to participate in the above survey: Date: Participant's signature:	



Informed consent

Project title: Smell and Interaction in Small Group Language Tasks	Date: 2, Mars,2026
Study manager: Tarek Alexander Khnijer Your E-mail Tarek_khnijer@hotmail.com	Studying at Malmö University, Faculty of Culture and Society, S-205 06 Malmö Phone +46 40 665 70 00 Education: interaction design Level: third year
I confirm that I have received written and verbal information about the study “Smell and Participation in Group Language Tasks.” I understand that the session will be audio and video recorded for research purposes. I understand that my participation is voluntary and that I may withdraw at any time without providing a reason. I understand that the collected data (audio, video recordings, and observational notes) will be stored on a password-protected device and will only be accessible to the researcher and academic supervisor. I understand that my identity will remain confidential and that pseudonyms will be used in the thesis. I understand that data will be stored securely for one year after the completion of the thesis and then permanently deleted. I give my consent to participate in this study.	
I hereby submit my consent to participate in the above study: Date: Participant’s signature:	



Information Letter

Project title: Smell and Interaction in Small Group Language Tasks	Date: 2 March 2026
Study manager: Tarek Alexander Khnijer e-mail Tarek_khnijer@hotmail.com	Studying at Malmö University, Faculty of Culture and Society, S-205 06 Malmö, Phone +46 40 665 70 00 Education: Interaction Design Programme Level: Bachelor Level
The following information should be included: – Presentation: This study is conducted as part of a bachelor's thesis in Interaction Design at Malmö University. The project explores how sensory materials, specifically smell, may influence participation in small-group language activities. – Aim: The aim of this study is to investigate how a sensory stimulus (smell) may shape interaction patterns during collaborative language tasks. – Implementation: Participants will take part in a short group activity lasting approximately 20–25 minutes. The group will either receive: • A mild, familiar scent or • A word prompt (e.g., “..”). The session will be audio and video recorded for research purposes. There are no known risks involved. However, if you have asthma or sensitivity to scents, please inform the researcher before participating. – The voluntary requirement: Your participation in this study is completely voluntary. You may withdraw at any time without giving any explanation – The confidentiality requirement: All collected material will be treated confidentially. Recordings will be stored on a password-protected device. Only the researcher and academic supervisor will have access to the data. In the final thesis, participants will remain anonymous. Pseudonyms will be used, and no identifying information will be published. The collected data (audio/video recordings and related materials) will be stored securely for one year after the completion of the thesis. After this period, all recordings will be permanently deleted.	



Information Letter

Project title: Smell and Interaction in Small Group Language Tasks	Date: 7, Apr 2026
Study manager: Tarek Alexander Khnijer e-mail Tarek_khnijer@hotmail.com	Studying at Malmö University, Faculty of Culture and Society, S-205 06 Malmö, Phone +46 40 665 70 00 Education: Interaction Design Programme Level: Bachelor Level
The following information should be included: – Presentation: This study is conducted as part of a bachelor’s thesis in Interaction Design at Malmö University. The project explores how sensory materials, specifically smell, may influence participation and interaction in small-group language activities. – Aim: The aim of this study is to investigate how a sensory stimulus (smell) may shape interaction patterns, including how participants initiate, respond, and collaborate during shared language tasks. – Implementation: Participants will take part in a short group activity lasting approximately 20–25 minutes. The group will either receive: • A mild, familiar or unfamiliar scent • A picture prompt (e.g., “...”) The session will be audio and video recorded to document interaction between participants for research analysis. The recordings will only be used within this project and will not be shared or published. There are no known risks involved. However, if you have asthma, allergies, or sensitivity to scents, please inform the researcher before participating. You may stop the activity at any time if you feel uncomfortable. Participants may be invited to answer a few short questions (5–10 minutes) after the activity about their experience. – The voluntary requirement: Your participation in this study is completely voluntary. You may withdraw at any time without giving any explanation. – The confidentiality requirement: All collected material will be treated confidentially. Recordings will be stored on a password-protected device. Only the researcher and academic supervisor will have access to the data. In the final thesis, participants will remain anonymous. Pseudonyms will be used, and no identifiable images or personal information will be published. The collected data (audio/video recordings and related materials) will be stored securely for one year after the completion of the thesis. After this period, all recordings will be permanently deleted.	



Informed consent

Project title: Smell and Interaction in Small Group Language Tasks	Date: 21, Apr, 2026
Study manager: Tarek Alexander Khnijer Your E-mail Tarek_khnijer@hotmail.com	Studying at Malmö University, Faculty of Culture and Society, S-205 06 Malmö Phone +46 40 665 70 00 Education: interaction design Level: third year
I give my permission for the researcher to use the image that includes me for the purpose of this bachelor thesis. I understand that the image will only be used for academic purposes and will be included in the written thesis and/or presentation. I understand that my identity will not be disclosed, and no personal information will be linked to the image. I understand that I can withdraw my consent at any time before the final submission of the thesis.	
I hereby submit my consent to participate in the above study: Date: Participant's signature:	