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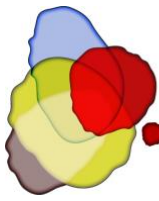
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With sensitive eyes: ECEC teachers' visual gaze and related reflections on pedagogical actions in toddler groups using eye-tracking glasses

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Abstract

This study explored early childhood education and care (ECEC) teachers' visual gaze and related reflections on pedagogical actions during pedagogical activities in groups of children under three years of age in Finland. The data were collected from play and teacher-guided activities using mobile eye-tracking glasses, the retrospective thinking aloud (RTA) method, and semi-structured interviews. The results showed that even though the teachers were surprised about some aspects of the visual gaze metrics, they reflected on and gave reasons for their visual gazes on children. When observing gaze data from play, teachers explained the high amount of gaze by citing children's particular needs. When observing gaze data from guided activities, teachers reflected on children's unpredictable behavior and noted that the children's need for support in concentration was linked to more gazes by the teacher. The findings showed that both during play and guided activities, children seeking a gaze and the position of children in the classroom influenced the number of teachers' gazes. In the teachers' explanations of their visual gaze and related pedagogical actions, five categories were identified: protection; physical and emotional availability, teaching and learning; facilitation; and initiatives. This explorative study showed that teachers utilize their knowledge concerning children's individuality, development, and learning when they explain their decisions concerning their visual gaze and pedagogical activities with toddlers. The use of mobile eye-tracking technology is relatively new; therefore, its applications to ECEC are pioneering for the development of the field in relation to the practices and research of toddlers' groups and groups with older children in ECEC.

Keywords: toddlers, teachers' gaze, eye-tracking glasses, visual gaze metrics, knowledge-based reasoning, teacher reflection and explanations

1. Introduction

A child's day in early childhood education and care (ECEC) is characterized by diverse pedagogical activities (Guedes et al., 2020). The teachers and their pedagogical actions in the ECEC groups are central in guiding these activities based on their values, knowledge, and perceptions of the children (Lunn Browlee et al., 2016). Thus, at the heart of these pedagogical activities is teacher–child interaction, which includes both verbal and nonverbal communication, such as body language, gestures, and visual gaze (Bae, 2009; Jamison et al., 2014; Salminen et al., 2021b). Currently, not much is known about ECEC teachers' visual gaze while interacting with children in authentic ECEC groups. Even though most of the eye-tracking research conducted in educational settings has not been directly related to ECEC, it has provided a starting point for designing the present study. For this reason, we will briefly mention eye-tracking studies conducted in elementary and high school settings. Elsewhere in educational research, teachers' visual gaze has been explored using mobile eye-tracking technology. Presently, mobile eye-tracking technology is increasingly being used to study teachers' visual gaze behaviors in various classroom settings in relation to their level of work experience and their knowledge of teaching and learning (Dessus et al., 2016; Goldberg et al., 2021; Huang et al., 2021; McIntyre & Foulsham, 2018; Shinoda et al., 2021). Furthermore, Muhonen et al. (2020) utilized mobile eye-tracking glasses to study primary and preschool teachers' distribution of visual attention during high- and low-quality educational dialogue. In the ECEC field, Ishibashi et al. (2020) and Sadamatsu (2022) studied the relationship between ECEC staff members' professional experience and visual gaze using eye-tracking glasses. Moreover, Isotalo et al.'s (2024) study focused on ECEC teachers' gaze behavior during various phases of pedagogical interaction with under three-year-old children.

These studies have raised awareness of teachers' visual gaze behaviors in school classrooms and, more recently, in ECEC and on teachers' professional vision in noticing and knowledge-based reasoning of the noticed situations (Seidel & Stürmer, 2014). This study aimed to fill the gap in knowledge that exists concerning teachers' visual gaze in ECEC contexts that are different from school classrooms. Our research also included, for the first time that we are aware of, ECEC teachers' reflections and explanations of their gaze and related pedagogical actions on the basis of their own visual gaze data. In this study, we concentrated on ECEC teachers' visual gaze during pedagogical activities in groups of children under three years old in Finland. We referred to our child participants as "toddlers," a term used to refer to 18- to 36-month-old children (Colson & Dworkin, 1997). Our aim was, first, to investigate ECEC teachers' visual gaze on children and their related reflections based on visual gaze metrics. Second, we explored teachers' explanations based on their own visual gaze and related pedagogical actions with children in toddler groups. Accordingly, teachers' visual gaze was investigated using eye-tracking recordings as well as both gaze metrics and verbal data (see McIntyre et al., 2020). The data were collected using Tobii Pro Glasses 2 eye-tracking glasses, the retrospective think-aloud (RTA) method, and semi-structured interviews with teachers. During RTA, teachers explained their actions based on what they looked at and described their reasoning in a review of their work and decision process in the classroom (Häggström et al., 2015). The findings from the present study will contribute to raising awareness of using eye-tracking technology with teachers in ECEC and evoke teachers' reflections on their visual gaze and related pedagogical actions.

1.1. Teacher´s pedagogical actions and interaction in toddler groups

The changing situations with under three-year-olds in ECEC groups require teacher's pedagogical awareness and sensitivity; in other words, teacher's "pedagogical glasses" are needed throughout the day. Pedagogy in ECEC can be interpreted as the actions, such as decisions and methods, of the teacher. Pedagogy is based on the strategies the teacher uses to bring children's competencies, skills, and ideas to the center of their educational actions (Pramling Samuelsson & Asplund Carlsson, 2008). The knowledge about learning, curriculum, theoretical basis of educational science, and children's development and learning guide teachers' pedagogical actions and decisions (Helavaara Robertson et al., 2015; Ranta et al., 2023). Thus, pedagogical actions with children include planning but

also teachers' capacity for evaluation and reflection of the practices (Kangas et al., 2021; Pihlaja & Holst, 2013).

Supportive and high-quality teacher–child interactions are known to promote children's emotional, social, and cognitive development (Organisation for Economic Co-operation and Development, 2018; Slot et al., 2018). Teachers in ECEC can stimulate children's thinking, reasoning, and language skills by asking questions and giving feedback (Guedes et al., 2020; La Paro et al., 2012; Thomason & La Paro, 2009), but they also support socio-emotional skills, such as children's self-regulation (Salminen et al., 2021a). In addition to teachers' high sensitivity toward children's initiations and expressions, teachers' ability to effectively monitor a group of children is measured as an indicator of high quality. Studies on preschool and toddlers' groups have revealed that interactions, and the quality of interactions between teachers and children vary across different activities during a day (Booren et al., 2012; Guedes et al., 2020; Whittaker et al., 2018). For example, a Portuguese study showed that when teachers were engaged in several practical demands, such as serving food during meals, interactions were less warm and sensitive than during free play and early academic skills (Guedes et al., 2020).

Based on this previous knowledge of the diversities in teacher–child interaction in activities during the day in ECEC, in this study, we chose to explore two different activities: play and guided activities. Play is a key activity for young children and a driving force for their development (Vygotsky, 1967). Teachers' role in play involves observing children's cues, aligning with their initiations, and being emotionally available to support children's contributions to play (Hakkarainen et al., 2013). In the present study, the play situations consisted of the teacher's choice of timing and toys as a structure, but the children were free to play using their own ideas and creativity in the presence of the teacher. We also chose guided activities that were more teacher-directed. In general, the teacher sets the goals, plans and leads the guided activities in ECEC to support the development of early academic skills, such as science, language, or math-oriented activities (Ranta et al., 2023). These activities are often implemented creatively through music, art, and physical education.

Teacher–child interactional processes include nonverbal and verbal communication. In terms of nonverbal communication, body language, gestures, and visual gaze (Bae, 2009; Jamison et al., 2014), as well as touch, play a meaningful role, particularly with toddlers (Johansson et al., 2021). The teacher's physical presence as well as lap (availability of lap, having children on the lap) has gained attention in research (Hännikäinen, 2015; Lucas Revilla et al., 2022). Touch is also used intentionally, as teachers believe that it benefits children's emotional development, is useful when building relations with the children, and supports learning (Johansson et al., 2021). It is also used to control the child. In addition, establishing eye contact with children is one way for teachers to encourage desired behaviors and establish strong relationships (Hietanen et al., 2008; Ledbury et al., 2004). There is also a growing amount of research underlining the active role and capacity of infants and toddlers to be active participants in interactions as they communicate through smiles, cries, and other emotional strategies (Salomon et al., 2017). Teachers' orientation toward these cues provides one important way for the child to be understood and acknowledged (Pursi, 2019), thus foregrounding teachers' visual gaze in interactions.

1.2. Teachers' visual gaze in educational research

In the teaching profession, it is important for teachers to constantly adjust their visual gaze based on multiple events that occur simultaneously in the classroom. Previous research in the school context showed that teachers face immediacy, unpredictability, multidimensionality, and simultaneity in complex classroom environments (Doyle, 1980). Teachers' visual gaze behavior has been popularly studied under the broader concept of teacher professional vision, which has been investigated based on teachers' ability to notice classroom events and provide knowledge-based reasoning for the noticed classroom events (Seidel & Stürmer, 2014). Knowledge-based reasoning means teachers' ability to utilize their knowledge to explain the situations they notice. Previous research has shown that teachers' knowledge-based reasoning consists of the three qualitative domains: description, explanation, and prediction (Seidel et al., 2011; Seidel & Stürmer, 2014; Sherin & Van Es, 2009). Explanation refers to

the ability of teachers to use what they know to reason the situation (Seidel & Stürmer, 2014). In this study, we examined teachers' explanations to determine what kind of knowledge-based reasoning they used when explaining their gaze and pedagogical actions during play and guided activities in toddler groups. Additionally, we gained information about ECEC teachers' noticing through their gaze metrics. Teachers explained classroom events through RTA and interviews, which were implemented while watching eye-tracking videos, and they had the opportunity to link the noticed situation to broader knowledge of ECEC pedagogy and expertise.

In ECEC groups, teachers use their visual gaze to notice children in their nonverbal interactions with them. In addition, teachers need to provide selective visual attention toward children to monitor, guide, and interact during pedagogical activities. In terms of the present study, visual gaze was defined as the total amount of time in terms of fixation durations teachers looked at the children and the number of visual fixations that occurred when teachers looked at the children (as used in previous studies of Chaudhuri et al., 2022a, 2022b; Isotalo et al., 2024). Accordingly, teachers need to use their visual gaze toward children in ECEC during both play and guided activities to observe children's social, cognitive, and motor skills' development and ensure their safety (Kangas et al., 2021). An earlier study in ECEC with eye-tracking glasses showed that experienced ECEC staff looked less often at children's faces than at other areas during snack time (Ishibashi et al., 2020). Moreover, the experienced ECEC teachers gazed at children more frequently but for shorter times when monitoring play situations (Sadamatsu, 2022). In a study by Isotalo et al. (2024), it was shown that the phase of the pedagogical interaction and structure of the activity have an influence on ECEC teachers' gaze behavior by increasing visual gaze toward children in child-initiated interaction and on materials during teacher-initiated interaction. Moreover, during structured music activities, teachers' gaze was usually more on children, but during play, it was more on materials.

Another eye-tracking study in secondary school classrooms showed that teachers initiated eye contact more with students when they gave directions and that students initiated eye contact more when the teacher showed affection (Haataja et al., 2020). Previous research has also shown that teachers may show dominance by increasing eye contact with students during questioning and show friendliness toward students by increasing eye contact while lecturing (McIntyre et al., 2020). In the application of a theoretical model called "Classroom Management Scripts," it was indicated that teachers use their visual gaze to improve their situational awareness of classroom events that occur during lessons to observe, detect, and trace classroom events in relation to children's learning and development (Wolff et al., 2020). Previous studies in schools have shown that teachers will gaze longer at children who face challenges in concentrating on tasks (Seidel et al., 2021). Children may also seek attention from teachers through their behaviors. In addition, students showing more interactive and disruptive behavior have been shown to receive more attention from teachers in terms of visual gazes (Goldberg et al., 2021). Since little is known about teachers' visual gaze behavior in ECEC settings, the present study examined teachers' visual gaze in terms of their visual fixation metrics, their reflections on this, and their explanations based on their own visual gaze and related pedagogical actions in toddler groups.

1.3 Aims of the study and research questions

The aim of this study was to investigate teachers' visual gaze and their pedagogical actions during pedagogical activities in ECEC groups with children under three years old. In ECEC, children are exposed to different interactional experiences during the day, which led us to select two different pedagogical activities (play and guided activity) where the gaze data were recorded. Accordingly, the present study examined and explored teachers' visual gaze on children, their reflections on the fixation gaze metrics, and their explanations based on their own visual gaze and related pedagogical actions in toddler groups.

We addressed the following research questions:

1. What do teachers' visual gaze metrics inform us about their visual gaze on children in play and guided activities, and how do teachers reflect on their visual gaze metrics?

2. How do teachers explain their visual gaze on children and their pedagogical actions during play and guided activities in ECEC groups with toddlers?

2. Methodology

2.1 Approach and the design of the study

In the present study, a case study design has been implemented to obtain an in-depth understanding of three ECEC teachers' visual gaze while conducting pedagogical activities in the classroom in the form of play and guided activities. The true essence of a case study lies in detailed investigation of a small sample focusing on specific aspects of a teacher's experience within a classroom (Tight, 2010). Accordingly, while exploring an individual ECEC teacher's case, firstly, a positivist approach was taken to investigate the quantifiable measure of their visual gaze using eye-tracking technology and secondly, an interpretive approach was taken wherein each teachers' subjective reasoning/explanation of their visual gaze was examined. Both the positivist and interpretive approaches provided a wholesome understanding of the way teachers support children in ECEC. However, it is important to note that the case study approach is merely descriptive (Flyvbjerg, 2006) and should not be used in making strong generalizations and conclusions on teaching and learning in ECEC groups in general.

2.2 Ethical issues

This project followed the ethical guidelines of the National Advisory Board on Research Ethics in Finland to maintain good scientific practice and conform to the applicable regulations for personal data use in scientific studies (Finnish Advisory Board on Research Integrity, 2012). The research proposal received approval from the ethics committee of the University of Jyväskylä, where particular attention was paid to the ethical assessment of the methodological approach and eye-tracking technologies used with young children. It was made clear to the study participants that their participation was completely voluntary. Permission was sought from the municipality, participating teachers and guardians of the children who gave their written informed consent to participate in the study. As the children's assent was negotiated throughout the process, their assent was observed by remaining sensitive to their nonverbal and verbal communication during the data collection (Rutanen et al., 2023). The anonymity of the participants was ensured, and pseudonyms were used in reporting. Particular care was paid during the reporting phase to eliminate any details that would make the cases identifiable.

2.3 Piloting recordings and orienting the children and teachers to eye-tracking glasses

Utilizing mobile eye-tracking glasses to collect data of the teachers' visual gaze in a toddlers' group is a fairly new research design; thus, we designed the research project one step at a time. The research team had previously established relationships with one Finnish ECEC center, the teachers, and the director of the ECEC unit. Before the data collection, the eye-tracking glasses were piloted in a preschool classroom (6-year-olds). Many technical details (such as calibration, connecting the equipment, and recording the video) and requirements concerning the circumstances were learned during piloting, such as that the curtains should be closed to prevent direct sunlight from distorting the recorded video to guarantee good quality of the data.

Before actual data collection, two researchers visited the selected toddler groups and introduced eye tracking glasses to the groups' teachers and children. The children were very curious about the glasses, and the research team answered the children's questions and showed the eye-tracking glasses to them. To get participants (teachers and children) familiar with the glasses and to minimize possible uncomfortable feelings regarding data collection and glasses, the teachers got the chance to test eye-

tracking glasses in the presence of participating children before the actual data collection. Finally, researchers asked permission from children to come after a few days to their group with the "funny glasses."

2.4 Research participants, data collection and data

The case study teachers, Rose, Joanna, and Maria were from the same ECEC center and conducted their pedagogical activities in their own groups of toddlers, while wearing eye-tracking glasses. The participating teachers had completed their bachelor's degree in early childhood education at a Finnish university. There was variation in the working experience (from one year and three months to four years) among the participating teachers; the average work experience was two and a half years. The age of the children who participated in this study varied from 29 to 36 months, with an average of 31 months. In one small group, there were from two to four children at a time (Table 1) and these small groups were formed by the teacher.

The data collection was done in two phases in fall 2021. In the first phase, each teacher was asked to implement one play activity and one guided activity with small groups of children. During eye-tracking video recordings, teachers were given the freedom to decide what these activities would contain and in what situation they would be implemented. In addition, teachers chose the toys that were given to children to play with during play activities and children were free to engage in play with these toys as and if they wished. It is possible that teachers' reflections and explanations can overlap between play and guided activities as these activities may not be often different from one another. More specific information about the content of the guided and play activities can be found in Table 1. Tobii Pro Glasses 2 were used to record eye-tracking videos of the participating teachers during these activities. Tobii Pro Glasses enable capturing participants' eye-movement data in authentic environments since, the glasses are mobile and allow participant to move their head and body freely. Additionally, these eye trackers enable multimodal data analysis by capturing not only the eye movement data, but also video and audio data of participants' actions. Before the recording of videos, two trained researchers calibrated the eye-tracking glasses using one-point calibration. The researchers asked the teacher to look at three set points in the room (such as the door, shelf, curtain, etc.) at the beginning of the video recording to verify that their gaze met the three determined points (Tobii AB, 2018). The researchers confirmed that teachers felt comfortable while wearing eye-tracking glasses during the data collection. To our surprise, the children paid little attention to the glasses and did not try to touch or reach for them.

The length of the eye-tracking video recordings varied from 12 to 32 minutes; the video data totaled 127 minutes, 32 seconds. The length of the individual recording depended on the length of the activity. During the recording of the shortest, a 12-minute recording, technical difficulties affected the duration of the video. The gaze sample percentage indicates the total percentage of time when at least one or both eyes were detected during the eye-tracking recording duration. In this study, as shown in Table 1, all eye-tracking video recordings above the 70% gaze sample percentage were considered (Chaudhuri et al., 2022a, 2022b, 2024). The teachers, children, activities, duration of videos, and the quality of the gaze sample are described in Table 1. The eye tracking video data was imported to Tobii Pro Lab analysis software for further analysis. Prior to the analyses, each eye-tracking video recording was coded using a coding criterion. In Tobii Pro Lab analysis software, it is advised to select a suitable filter which is best for filtering eye movements from participants whose visual gaze movements were recorded from real-world settings wherein they moved around freely. Accordingly, for our eye-tracking video recordings, the I-VT (attention) filter settings were best suited to filter out fixations from teachers' eye movement data. Next, an experienced coder manually mapped fixations onto the areas of interest (AOIs) where the teacher looked. These areas of interest were pre-determined. After coding the eye-tracking video recordings, fixation metrics were exported for further analyses of the case studies of 3 example teachers in our study.

In the second phase of the data collection, the RTA method and interviews were used wherein teachers watched their own eye-tracking video recordings and reflected on their actions. For the RTA, teachers were given instructions orally and these instructions can be found from Appendix C. Due to

the limited number of previous studies using eye-tracking in ECEC, our exploratory research design involved using both RTA and interviews. In doing so, we were able to gain deeper insight from the teacher about the teaching situations, their experiences and reflections on using the glasses. RTA is a valuable method for identifying teacher's pedagogical expertise and observing how professionals operate from moment to moment (Fox et al., 2011). Earlier studies have shown that eye-tracking recordings can be used as part of RTA (McIntyre et al., 2019; Muhonen et al., 2022). The RTA was followed by a short semi-structured interview wherein teachers were asked questions in relation to their experience concerning the eye-tracking video recording. More specific information of the interview protocol can be found in Appendix C. During the interviews, teachers were asked if they would like to add more reflections concerning the eye-tracking video recordings. Additionally, bar graphs obtained from eye-tracking video analysis were used as stimuli to elicit responses from the teachers. Both the RTA and interviews were recorded using a voice recorder and recorded data totaled 222 minutes and 16 seconds. Interview data was transcribed for further analysis

Table 1

Teachers, children, activities, duration of videos, and quality of gaze sample

	Content of the activity	Activities in lesson	Duration of eye- tracking video (in minutes)	Gaze sample percent
Teacher: Rose *Children*: Alma, Elisabeth, Betty & Jasmin	Play: Lego play	Teacher and children are playing and discussing together.	16.18	94 %
Teacher: Rose *Children*: Alma, Elisabeth & Jasmin	Guided situation: Music	Teacher and children sing and make hand gestures.	15.31	93 %
Teacher: Joanna *Children*: Vincent & Adam	Play: Train track play	Teacher and children are discussing, designing, and building train tracks together.	19.46	88 %
Teacher: Joanna *Children*: Vincent & Mathias	Guided situation: Fingerpainting	Teacher was guiding the children's painting. Children were free to choose what they would like to paint.	31.45	91 %
Teacher: Maria *Children*: Oliver & Emil	Play: Magic sand play	Teacher gave examples and discussed with children how to mold sand into different shapes.	32.02	84 %
Teacher: Maria *Children*: Oliver & Emil	Guided situation: Music	Teacher was using song cards. The teacher and children were singing and playing together.	12.10	74 %

2.5 Analysis

In the present study, both the teachers' eye gaze and verbal data were utilized (see McIntyre et al., 2019). Teachers' visual gaze and gaze metrics were indicated by eye-tracking metrics in terms of fixations, and the verbal data from RTAs were used to explain and justify the teachers' visual gaze and their pedagogical actions in the toddler group.

The eye-tracking video recordings were analyzed using Tobii Pro Lab v. 1.171 (Tobii AB, Danderyd, Sweden). There were two eye-tracking video recordings from each teacher wherein one was showing a play activity, and the other was showing a guided activity led by the teacher. The data analysis was done in several steps, and both videos were analyzed using the same steps. In the first step, areas of interest (AOIs), which are targets in the surroundings on which the teacher focused during play and guided activities, were identified from the eye-tracking video recordings (Holmqvist et al., 2015). In the present study, the AOIs were targets (such as children, and teaching materials) toward which the teacher focused their visual attention during pedagogical activities (as seen previously in Chaudhuri et al., 2022a, 2022b; Muhonen et al., 2022).

In eye-tracking, fixations are defined as the duration of time when eyes remain relatively still and input of new information takes place from the immediate environment by selectively focusing on targets (Rayner et al., 2009). The second step involved manually mapping the teachers' eye gaze in terms of fixations onto the specific AOIs (set as stationary pictures in the Tobii Pro Lab), as shown by a red circle on the eye-tracking video recording. In the third step, after manual mapping of teachers' eye-gazes on the respective AOIs, the eye-tracking metrics related to teachers' fixations were obtained in total duration of fixations, average duration of fixations, and number of fixations from the software. The fourth step involved developing visual representations in the form of bar graphs from the teachers' eye-tracking metrics, such as total fixation duration, average fixation duration, and number of fixations using Microsoft Excel (Microsoft, Redmond, WA, USA). In this study, we utilized teachers' gazes in terms of fixations toward children because we were interested in the amount of time teachers gaze at children during teacher-child interactions. The other gazes, for example, toward toys, walls, or furniture were left out of this study. Inter-coder reliability was checked by double coding 20% of the videos from the entire dataset. Double coding agreement ranged from 75% to 99.8%, with an average of 91.8%.

The RTA data and interviews were analyzed using a qualitative approach. The transcribed data were reduced, categorized, and classified (Holloway, 2011). The analysis followed abductive reasoning, and previous theoretical concepts partially guided this analysis, but the categories were created inductively (Cohen et al., 2007). The focus was on the reflections and explanations given to their visual gaze and their actions in the pedagogical activities recorded. The analytical process followed the principles of triangulation (Flick, 2004). Two researchers conducted preliminary analysis and categories from the qualitative data. After that, we discussed the preliminary findings among the entire research team. This process involved individual and shared interpretations and reflections, leading to the identification of the final categories of teachers' explanations of their visual gaze and their pedagogical actions during play and guided activities.

3. Findings

3.1 Teachers' visual gaze metrics and related reflections from bar graphs

The answer to our first research question is based on the coded teachers' visual gaze data and teachers' reflections when they saw the visual gaze metrics (bar graphs) related to the eye-tracking videos. Moreover, teachers' answers to semi structured interview questions were utilized on this section. In the following results subsections, we present the table of coded teacher's eye-tracking data related to play and guided activities (Tables 2 and 3) and reflections of each teacher concerning the fixation-related eye-tracking metrics, such as total duration of fixation, average duration of fixation, and total number

of fixations. Examples of bar graphs that was showed to teachers, can find from Appendix A. In the end of this section Table 4 is presenting the main findings of this first research question.

3.1.1 Teachers' visual gaze metrics from play and their reflections on them

This result subsection discusses both the eye-tracking metrics on teachers' visual gaze during play activity and their own reflections after seeing the bar graphs concerning these activities. In terms of descriptive statistics, the mean total duration of fixation in play was for Rose (M=109,640; SD=14,730), for Joanna (M=243,598; SD=69,821) and for Maria (M=139,638; SD=62,217). Table 2 shows each teacher's total duration of fixation, average duration of fixation, and total number of fixations directed toward each participant child in the activity. A visual representation of the variation in three teacher's visual gaze metrics in terms of total fixation duration and number of fixations are shown in Appendix B, namely figures B1, B2, and B3. These figures add to the in-depth understanding of each teacher's visual gaze in play and guided scenarios.

Table 2

Fixation metrics concerning teachers' visual gaze during play

Teacher	Child	Total duration of fixations (ms)	Average duration of fixation (ms)	Total number of fixations
Rose	Alma	116,831	526	222
	Elisabeth	88,688	490	181
	Betty	122,248	497	246
	Jasmin	110,794	486	228
Joanna	Vincent	292,970	490	598
	Adam	194,227	482	403
Maria	Oliver	183,633	220	834
	Emil	95,644	205	467

Note. ms = milliseconds.

As can be seen from Table 2, teachers visual gaze fixation metrics in terms of their eye-tracking data varied between the individual children during play activities. Next, teachers explained and reflected on these variations during play activities when they read their own bar graphs that were plotted using their visual gaze data (example of bar graphs can be find from Appendix A).

Rose's reflections on her visual gaze during the play activity

Teacher Rose specifically noted that the duration of fixations on Betty was higher than to other children in activity. She explained that Betty had some challenges in understanding speech, so she needed stable eye contact when communicating. This increased the total duration and total number of fixations on Betty. Data on Table 2 seconds Roses explanations. Total duration and number of fixations were higher with Betty. Moreover, with Alma the average duration of fixations was higher, and it seems that the total duration of the fixations of Betty consisted of shorter fixations. However, only Elisabeths total duration of fixations was lower than the mean total duration of fixations.

Joanna's reflections on her visual gaze during the play activity

From the visual gaze metrics, teacher Joanna first noted and was surprised by the number of and total duration of fixations on Vincent. To Joanna, this communicated that Vincent was seeking contact. Joanna also noticed fewer fixations on Adam and commented on him being self-directed and needing less guidance, focus of attention, and gazes. As from Table 2 can be seen, the data supports Joanna's explanations. The difference between the total duration of fixations between Vincent and Adam was

quite high but the average duration of fixations was almost the same. This indicates that the lengths of teacher's gazes in general were similar toward both children, but Vincent got more gazes.

Maria's reflections on her visual gaze during the play activity

After seeing the visual gaze metrics, teacher Maria explained that she had longer discussions with Oliver because Oliver was more communicative, and this increased the total duration of fixations on him. Maria tried to contact Emil, but he did respond that much. Maria also wondered whether her position being next to the table that they were playing on had affected the number of fixations on children. She had to turn her head to see children playing next to her. As a result, in this situation, when Oliver was more active in communication and sought more of her attention, this position and Oliver's activeness increased the total number of fixations on Oliver. The data presented in the Table 2 supports Marias' explanations. The total duration and number of fixations for Oliver was higher than for Emil. Moreover, Emils total duration of fixations was under the mean total duration of fixations.

3.1.2 Teachers' visual gaze metrics from guided activities and their reflections on them

In this subsection, we present the eye-tracking metrics and teachers' reflections on the bar graphs concerning guided activities. In terms of descriptive statistics, the mean total duration of fixation in guided activities was for Rose (M=181,335; SD=88,899), for Joanna (M=348,087; SD=45,836) and for Maria (M=34,970; SD=4,876). Table 3 presents each teacher's total duration of fixation, average duration of fixation, and total number of fixations directed toward each participant child in the activity.

Table 3

Fixation metrics concerning teachers' visual gaze during guided activities

Teacher	Child	Total duration of fixations (ms)	Average duration of fixation (ms)	Total number of fixations
Rose	Alma	182,974	556	329
	Elisabeth	91,627	475	193
	Jasmin	269,404	549	491
Joanna	Vincent	380,498	516	737
	Mathias	315,676	557	567
Maria	Oliver	38,418	179	215
	Emil	31,522	178	177

Note. ms = milliseconds.

As it can be seen from Table 3, teachers gaze fixation metrics varied between the individual children. When showing bar graphs to the teachers, made using gaze metrics from Table 3, they gave some explanations to their visual gaze in guided activity.

Rose's reflections on her visual gaze during the guided activity

Teacher Rose explained the large number of fixations focused on Jasmin on the basis of her physical location. Children were sitting in line, and Jasmin was sitting in front of her (Smidekova et al., 2020). In turn, Elizabeth, who participated in and concentrated on music sessions, actively got fewer gazes than the other children. Rose explained that she knew that she could trust her participation without a need to actively look toward her. When looking at Table 3, the data seconds these explanations. Jasmin got most fixations and also total duration of fixations was highest on her. In addition, for both Jasmin and Alma the total duration of fixations was higher than the mean total duration of fixations, indicating that in general Rose gazed towards them more than towards Elisabeth.

Joanna's reflections on her visual gaze during the guided activity

Teacher Joanna explained that Mathias was concentrating the whole time on an ongoing painting and did not need so much encouragement. She wondered if this might have reduced the total number of fixations on him. In addition, Joanna mentioned that when she looked at Mathias, she knew that he had something important to say or that he needed some care. This increased the average duration of fixations on Mathias. Data in table 3 seconds the explanations of Joanna. The difference in the total duration of fixations between Vincent and Mathias was quite high. The average duration of fixations also supports teachers' explanation by it being higher with Mathias, indicating that the total duration of Vincent's fixations consisted of shorter fixations.

Moreover, for Joanna it was surprising how in both situations (play and guided activity), Vincent had more fixations than the other children (Adam and Mathias) because in her interpretation, the other children were both more self-directed. She wondered if her relationship with Vincent might have affected this. She wondered if Vincent might have sought attention because he was used to getting it from her.

Maria´s reflections on her visual gaze during the guided activity

Teacher Maria pointed out that Oliver had had a bad day, and he got more gazes because of exceptional behavior. In this situation, Maria explained that Oliver needed support for concentrating and gazes were a means to that end. Data shows in Table 3, that the difference in the total duration between the children was quite low and the average duration of fixation was almost the same. In addition, a higher number of fixations supports Marias explanation of Oliver getting more gazes. Moreover, towards Oliver, the total duration of fixation was higher than the mean total duration of fixations.

Table 4

Summary of findings from teachers' visual gaze metrics and related reflections from bar graphs

Teachers' pedagogical activities	Teacher	Findings from teachers' visual gaze metrics and related reflections from bar graphs
Play activity	Rose	• Longer fixation durations were on Betty than other children because she had **challenges in understanding speech** and needed stable eye contact when communicating.
	Joanna	• More fixations were on Vincent as he was **seeking more contact**. • Fewer fixations were on Adam as he was **self-directed and needed less guidance** and attention.
	Maria	• More fixation durations were on Oliver as he was **more communicative, and the teacher's position was closer** to him.
Guided activity	Rose	• More fixations were on Jasmin as **the teacher was physically closer**. • Fewer fixations were in Elizabeth as she **concentrated better**.
	Joanna	• More total fixation duration was on Vincent as he was **seeking more contact**. • More average fixation duration was on Mathias as he **received visual attention whenever necessary.**
	Maria	• More fixation duration was on Oliver as he **showed exceptional behavior** and **needed support for better concentration**.

3.2 Teachers' explanations of their visual gaze and their pedagogical actions during play and guided activities in toddler groups

To address the second research question, the RTA and interviews were analyzed qualitatively. In this results subsection, we describe the categories and provide concrete examples from the RTA and interview data. We identified categories regarding teachers' noticing certain children and their explanations of pedagogical actions in relation to the noticed children. The categories were *protection*, *physical and emotional availability, teaching and learning*, *facilitation, and initiatives*. In this section, teachers' reflections from play and guided activities are discussed together as the five identified categories characterize the explanations on both play and guided activities. In the end of this section, Table 5 is presenting the main findings of this second research question.

3.2.1 Teachers protecting children from harm and maintaining safety

Teachers' explanations that were categorized under protection were linked to the physical safety of the children and protective caring of a child with particular needs in the situation. Teachers mentioned the need to observe children so that they would not hurt or cause harm to themselves or others in any way; thus, observation was linked to prevention of harm. Rose recounted in her interview that she had to restrict Jasmin from running because she had been ill, and the movement could cause her to cough:

> *Well at first, I still tried to get them to play with the Legos, and I knew that one of the children had recently been ill, so I didn't want her to run yet and start coughing again based on her parents' request.* (Teacher Rose, interview)

In this example, the focus is on the healthcare of the child; thus, the observations and lengthy gazes toward certain children were explained as important to be able to guarantee physical wellbeing of the child.

3.2.2 Teachers' physical and emotional availability to respond to children's needs

Our second category consisted of explanations in which the teachers emphasized them being physically and emotionally present for the children. In this category, teachers reflected on touch and bodily interaction linked to gaze. Emotional availability also occurred in situations where teachers reacted to children's nonverbal cues. Also, verbalized sensitivity was recognized. For example, Rose mentioned that Jasmin needed consolation and got more attention when she came into the room crying. Rose also took Jasmin onto her lap to reassure her. Furthermore, Maria explained that it was important to her that the children felt noticed and emotionally safe during the play. For example, she used touch to make sure that Emil knew she was speaking to him when Emil was playing further apart from Maria. This way she used touch to make the child feel welcome and Maria also intentionally switched her position to be closer to Emil.

Maria was very sensitive to the children's body language. She got signals about Oliver's need to go to the bathroom. Oliver was stepping around and crossed his legs and hands. So, Maria inquired if he needed to go to the toilet:

> *As the children are toilet training, and they are now both without diapers, I need to remind them at times.* (Teacher Maria, RTA)

3.2.3 Teaching and learning in pedagogical activities

Our third category concerning teachers' explanations of their visual gaze on certain children and teachers' associated behavior can be linked to *teaching and learning*. These explanations show how teachers' gazes on children are linked to pedagogical planning, observations, and solutions. In addition, guidance for learning was characteristic of this category. Teachers particularly mentioned the

importance of supporting children's language skills, consideration of children's individuality, and consideration of children's interests. In addition to observing children's interests, teachers verbalized and narrated actions and objects to children. Rose emphasized the importance of teachers speaking aloud to support the development of children's language. In addition, Joanna mentioned the value of naming directions and sizes, such as up, down, uphill, downhill, small, and big, during a free play:

> *Especially in the 0–3-year-old children's group, it is very important to name things in the surrounding world. As the children are still in different phases of learning to speak, and they cannot yet name things, I find it very important for the teacher to do so. That is, then, how the children can also learn new words and concepts.* (Teacher Rose, interview)

The teachers often observed and recognized the children's cues and showed flexibility in their pedagogical activities. For example, Joanna noticed that the art sessions had developed more through children's actions than by her original plan. During play, Maria also took ideas from children and praised them for their ideas. This way, teachers enhanced their participation (e.g., Ukkonen-Mikkola & Fonsén, 2018).

3.2.4 Facilitation supporting child's persistent engagement on activity

The fourth category that characterizes diverse explanations for teachers' visual gaze and related pedagogical actions is f*acilitation*. In this category, explanations focus on teachers' gazes toward certain children, and teachers' pedagogical actions that are associated with motivating the children to continue, and give guidance, ideas, and examples to children. These situations provided evidence of teachers' precise observation skills and willingness to engage children during pedagogical activities. When reflecting on the eye-tracking videos, Joanna explained that she utilized her prior knowledge about Vincent's individual characteristics in the given situation, wherein Vincent's behavior showed that he was not concentrating on the task and seemed distracted (sleepy and demotivated). After observing these situations, Joanna encouraged Vincent to return to the task using verbal communication (e.g., Salminen et al., 2021b).

Teachers paid attention to how they tended to give examples of the way a pedagogical activity should be performed. When observing the videos, Joanna also noticed that Vincent, at some point, was becoming exhausted and was not that interested anymore in pedagogical activity. Joanna pointed out that when she noticed that Vincent needed motivation, she tried to give guidance and some new ideas in relation to what he could paint. To encourage Vincent to continue, Joanna used verbal encouragement and reinforcement to motivate him in the given situation.

Maria noted her gaze toward Oliver and underlined that when she noticed that Oliver could not concentrate on the pedagogical activity, she directed him to alternative tasks in order to ease his disruptive behavior, linking the gaze to classroom management:

> *Still, it's interesting to notice that you can somehow steer him [Oliver] to take the Christmas gnome [a toy] into his lap or ask him to get the gnome. (Teacher Maria, RTA)*

3.2.5 Interaction initiatives between teacher and children

The fifth category of teachers' explanations of their visual gaze and pedagogical activities were *initiatives*. The initiatives are linked to interaction between the teacher and the children. Teachers reflected on their visual gaze and emphasized that children were seeking opportunities to interact with teachers using verbal and nonverbal cues. When observing the eye-tracking videos, Rose explained how she paid attention to children. She took the children's verbal initiatives into account, and when they suggested something, she immediately integrated the verbal initiatives into the pedagogical activities. Additionally, Rose stressed that it is very important to react warmly to children's initiatives. Maria also noticed that Oliver sought confirmation from her by constantly asking her to see what he had done:

I noticed the need to be kind of reassuring there, and I repeated what he thought he had done. I know that he needs a lot of reassurance in a positive way. (Teacher Maria, RTA)

Furthermore, the teachers noticed the children's nonverbal initiatives. When observing the videos, Joanna reflected on attention seeking. For instance, first, Vincent tried to establish eye contact with Joanna. Second, he made bodily gestures to seek visual attention from Joanna. Furthermore, when reflecting the eye-tracking videos, she interpreted Vincent's behavior as getting tired or bored with the ongoing action. This interpretation is based on Joanna's prior knowledge of Vincent.

In some cases, there were also initiatives that were difficult for teachers to interpret. Joanna noticed that she did not quite understand what Mathias was pointing at and that Mathias was getting frustrated because of it:

This older child (Vincent) is clearly seeking my attention by acting very small. (Teacher Joanna, RTA)

Additionally, teachers reflected on their own initiatives. These initiatives were invitations, comments, enquiries, and encouragement of the children. Rose made the initiative by inviting a child to Lego play. Joanna mentioned that she has a very conversational way of interacting, and she asked children a lot of questions:

[I have a] fairly talkative way to do everything with the kids. I talk a lot, and at times I know that the kids are also used to me talking and if they communicate with me, especially the other kid in my small group, you can notice that he [Vincent] seeks, for example, eye contact and knows that I chat and ask questions. (Teacher Joanna, RTA)

Table 5

Summary of findings from teachers' explanations of their visual gaze and related pedagogical actions during play and guided activities in ECEC

Categories	Examples of teachers' explanations of visual gaze and pedagogical actions during play and guided activities
1. Teachers protecting children from harm and maintaining safety	• Physical safety of the children • Protective caring for a child with particular needs • Prevention of harm
2. Physical and emotional availability: Teachers' physical and emotional availability to respond to children's needs	• Touch and bodily interaction linked to gaze • Reaction to nonverbal cues • Verbal sensitivity in terms of consoling a crying child • Physical closeness to a child
3. Teachers' teaching and learning in pedagogical activities	• Pedagogical planning, observations, and solutions • Providing guidance for learning • Supporting children's language skills and consideration of children's individuality and interests • Observing children's interests, teachers verbalized and narrated actions and objects to children • Speaking aloud to support the development of children's language
4. Facilitation supporting the child's persistent engagement in activity	• Motivating the children to continue • Giving guidance, ideas, and examples to children

5. Interaction initiatives between teacher and children	• Observing and responding to children's verbal and nonverbal cues
	• Integrating verbal initiatives into pedagogical activities
	• Reacting warmly to children's initiatives
	• Providing confirmation and validation to children

4. Discussion

4.1. Summary and discussion of the findings

The aim of this study was to examine ECEC teachers' visual gaze and pedagogical actions during pedagogical activities (play and guided activities) in groups of children under three years old in Finland. First, the present study investigated ECEC teacher's visual gaze metrics in terms of children and how teachers reflected on their own fixation durations from these metrics when they saw the bar graphs obtained from eye-tracking video analyses. Second, the aim was to investigate how teachers explained their visual gaze toward children and their pedagogical actions during play and guided activities.

The results showed that when the ECEC teachers saw bar graphs of their visual gaze, they were surprised at the differences in their visual gaze in the durations of fixations among children in the pedagogical activities. However, the ECEC teachers were able to give rational reasons for their visual gaze. Our findings indicate that the teachers attributed the high duration of visual gaze during play to the children's individual needs. This is in line with a previous study wherein teachers focused their visual attention longer on students based on individual support needs (Chaudhuri et al., 2022a; Seidel et al., 2021). Furthermore, teachers attributed a high duration of visual gaze during guided activities to children who showed unpredictable behavior and needed support to concentrate on the given task (van den Bogert et al., 2014). This is also in accordance with previous research, which showed that teachers look more at students who are off task or exhibit unpredictable behavior than students who participate actively in the classroom (Shinoda et al., 2021). In addition, the teachers gave a longer visual gaze in terms of fixation duration to students requiring reassurance and emotional support. This agrees with previous research showing that ECEC teachers need to provide emotional support to toddlers in order to reduce unpredictable behavior, such as tantrums, and encourage task-related behavior engagement (Shafer et al., 2022) as well as to offer emotional support and enable a safe and supportive relationship to be built for children's communication and diverse expressions (Salomon et al., 2017).

The findings showed that during both play and guided activities, children who sought contact got more gazes. These findings align with previous studies showing that teachers give more visual attention to students when they show interactive or disruptive behavior (Goldberg et al., 2021). In addition, we found that the physical position of children in the room and their distance to the teacher influenced the frequency and duration of the teacher's visual gaze. This is partially in line with previous research showing that students who are closer to the teacher may get more gazes than others (Smidekova et al., 2020).

In our second results subsection, we described how teachers explained their visual gaze toward children and their related pedagogical actions during play and guided activities. Five categories regarding teachers' explanations were identified. The categories were protection, physical and emotional availability, teaching and learning, facilitation, and initiatives. In toddler groups, teachers prioritized the protection of the physical health and safety of children in the classroom. Teachers observed the safety of children by being alert with their visual gaze. These findings agree with earlier

studies that found that the protection of safety is an integral part of activities with children (Gonzalez-Mena, 2002; Kettukangas, 2017). In addition, ECEC teachers showed physical and emotional availability through verbal and nonverbal approaches. Earlier studies have shown that teachers often use touch and verbal sensitivity toward children in ECEC (Hännikäinen, 2013; Thomason & La Paro, 2009). This could also be in response to the children's behavior showing sadness and loneliness, wherein the teacher communicates emotional availability by reassuring the child. This kind of emotional availability has been recognized as a key aspect of teachers' expertise in earlier studies (Harkoma et al., 2021). In these two categories, the knowledge of children's individual health, physical development, and interaction was utilized.

According to our results, teachers select their pedagogical activities based on their conceptions of teaching and learning principles. They focus on developing children's linguistic skills and consider their interests and individuality. The teachers remain flexible with their plans for the day and incorporate the children's interests during the lessons (La Paro et al., 2012.; Ukkonen-Mikkola & Fonsén, 2018). These findings are in line with earlier studies, which showed that children's participation is an essential part of ECEC pedagogy (Kangas et al., 2021). In addition, teachers need to model instructions for children to follow and learn. We found that teachers are aware of the importance of speech in daily activities and that children's learning is constant throughout the whole day in all activities and interaction situations. This result supports the idea that pedagogy in ECEC is implemented throughout the whole day (Lämsä, 2021). In this category, teacher's conceptions of teaching and knowledge of a child's cognitive development and individuality have been taken into account.

Teachers facilitate a child's persistent engagement in activity and offer guidance when children face challenges while concentrating. Children often need encouragement and verbal guidance from the teacher to maintain their attention toward and concentration on a given task (Salminen et al., 2021b). Teachers could also provide this guidance using their visual gaze, for example, by establishing eye contact. This finding is in line with earlier studies (Haataja et al., 2020). Finally, teachers need to consider children's verbal and nonverbal initiatives during lessons. Since children in ECEC groups are quite young, they often practice their social skills by initiating communication and interacting with their teachers and peers. These nonverbal cues have also been identified in earlier studies (Pursi, 2019; Salomon et al., 2017). Moreover, teachers need to invite children to participate in discussions, comment on children's tasks and inquire about children's interests and feelings. These teachers' initiatives are an essential part of ECEC pedagogy and their interactions with children (Clark, 2005; Ranta et al. 2023). In these two categories, the teachers utilized their prior knowledge related to individual children.

4.2. Conclusions, limitations, and future studies

Our findings indicate that ECEC teachers utilize their prior knowledge concerning children's individuality, development, learning, and interaction when they explain their visual gaze and decisions concerning the pedagogical actions with children. These explanations based on prior knowledge about the child and the child group in general are in line with what could be interpreted as one aspect in knowledge-based reasoning (Seidel et al., 2011; Seidel & Stürmer, 2014; Sherin & Van Es, 2009). However, in this study, we did not intend to explore the concept of knowledge-based reasoning any further but focused on the explanations given to gaze metrics and pedagogical actions in a more general manner. According to our findings, knowledge-based reasoning can broaden teachers' professional vision, in other words, teachers' ability to notice activities in toddler groups and reasoning for their pedagogical actions (see Seidel & Stürmer, 2014).

Further, we can state that the teachers' gaze behavior has some similar aspects from ECEC groups to school classrooms, including secondary school. Overall, in our study, the teachers' reflections and explanations suggest that the teachers approached these activities not only as situations that included both intentional teaching but also the education and care of children, as they are more broadly understood. Through their pedagogical actions, it was possible to interpret that their approach to

pedagogy was holistic, in line with the Finnish curricula framework for early childhood education. In the Finnish framework, the teaching, learning, and caring for children are implemented together throughout the whole day. This interpretation is in harmony with the Finnish ECEC curriculum (Finnish National Agency for Education, 2022; Lämsä, 2021).

There are some limitations to this study. One is that the research participants (teachers) were familiar with one of the researchers even before the study was conducted. Social relationships between informants and researchers can affect the objectivity of the research (Atkins & Wallace, 2012). However, as there was a group of researchers, it was possible to reflect jointly on the interpretations from diverse perspectives and critically form an outsider's perspective, as not all were familiar with the setting. The other possible limitation was the small number of research participants; therefore, the results cannot be generalized extensively (Lincoln & Guba, 2000). Moreover, teachers participating in the study were all in the early stages of their career, therefore comparing teacher s' visual gaze based on their experience was not relevant. Moreover, children who participated in individual data collections varied based on who was present in ECEC that day when data were collected. Therefore, comparisons of the teacher's visual gaze between the activities (play and guided) and between the children were not possible. Additionally, in this study children's background information was not collected. However, in future studies it is recommended to collect data regarding children's social habits and relationship with teacher to gain deeper insights related to ECEC teachers' visual gaze.

Regardless of these limitations, our study contributes to educational research especially as it utilized eye-tracking technology in ECEC research. This was one of the first exploratory studies in ECEC settings in Finland, and our endeavor was to give an in-depth insight to the way teachers use their visual gaze to reflect on their pedagogical activities with children. With these exploratory and descriptive findings, we contributed to the existing literature of teachers' professional vision in ECEC settings. Methodologically data triangulation, where eye-tracking metrics, RTA, and interviews are combined, is a useful design for analysis. It also strengthens the validity of the results (Flick, 2004). The benefits of data triangulation were clearly evident in this study, as the qualitative data were paramount in understanding the reasons behind the observed gaze behavior. Previous research has shown that visual gaze metrics obtained from eye-tracking video data may not be meaningful on their own unless they are combined with other data sources. For example, Van den Bogert et al. (2014) combined teachers' verbal reports or RTA explaining their observations along with their visual gaze data. In the present study, teachers' interview data and RTA provided justifications related to the variations of teachers' visual gaze on the children during their pedagogical actions. In future research, it would be advisable to use data sources other than interviews. For example, physiological data, children's classroom experiences, etc., could be used for improved data triangulation.

The practical implication of our study is that it is essential to understand the role of the teacher's gaze in the interaction and pedagogical actions in authentic ECEC activities with toddlers. This understanding can support teachers in their reflections on their focus of attention and pedagogical actions during interaction situations. Eye-tracking metrics can be used to facilitate teachers' reasoning in their pedagogy and in this way enable the development of teachers' understanding of their pedagogical actions. These findings can also be utilized in ECEC teacher training to enhance the understanding of the importance of noticing, reasoning, sensitive interaction, and teachers' pedagogical actions with toddlers. In addition, the study reveals the possibilities that eye-tracking technologies offer to researchers for studying interactions and teacher's pedagogical expertise and awareness of their visual gaze and pedagogical actions toward children in ECEC groups.

This study opens several future research directions. In future research a bigger dataset would enable to group children based on their age, gender, interests, and to investigate how these factors may influence ECEC teachers' visual gaze and makes possible also the comparison of teachers´ gaze behavior between activities and children. Additionally, extending the research to activities during the

entire day including outdoor activities is worth exploring. A more explicit study of nonverbal interaction between teachers and toddlers with eye-tracking technology would be a useful goal for future research. In addition, it is possible to utilize eye-tracking metrics to identify the differences between novice and expert teachers' gazes as well as the gazes' concerning interactions between teachers or between teachers and parents. Furthermore, including the gazes of toddlers would be a useful aspect of research. Using gaze metrics linked to child development and developmental psychology would provide a new and relevant research field.

Key points

- Although teachers were surprised about some aspects of the visual gaze metrics, they explained their gazes on children.
- Children's particular needs, unpredictable behavior, need for support to concentrate, gaze seeking, and the position of children increased teachers' gazes toward children.
- Five categories concerning explanations of teachers' visual gazes and pedagogical actions were identified.
- Teachers used knowledge-based reasoning when explaining their actions.
- Eye-tracking technologies can be utilized when studying teacher's pedagogical actions and reflections in ECEC.

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Appendix- A

In Appendix-A, Figure A1 shows the example of one case study teacher, Rose's visual gaze metrics. After recording the eye-tracking videos, Teacher Rose's visual gaze was coded and thereafter visually represented in the form of bar graphs. Bar graphs A1.1, A1.2, and A1.3 showed Rose's visual gaze metrics on children during play activities and bar graphs A1.4, A1.5, and A1.6 showed Rose's visual gaze metrics on children during guided activities. These bar graphs were shown to Rose in order to evoke reflections related to her visual gaze on children.
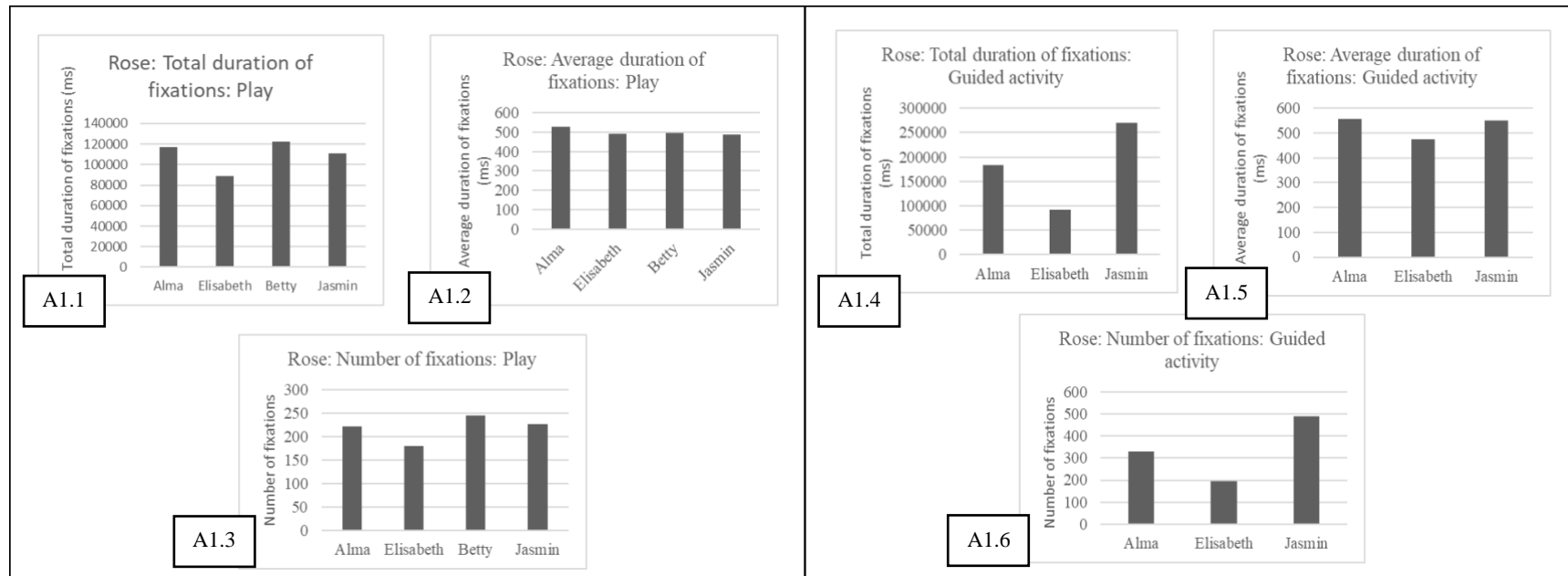
Figure A1. Example of bar graphs shown to Teacher Rose to evoke their reflections related to their visual gaze.

Appendix- B

In Appendix-B, Figure B1, B2 and B3 showed how Teacher Rose, Joanna, and Maria's visual gaze on children varied in play and guided activities. In the case of Teacher Rose, one child, Betty, was not present in the guided activity. Additionally, in the case of Teacher Joanna, Adam was present in the play but not in guided activity, whereas Mathias was present only in guided and not in play activity. In the case of all three teachers, it is visible that teachers' visual gaze duration is not equal and varies from child to child. These variations are explained by teachers in sections 3.1 and 3.2 of the present study.
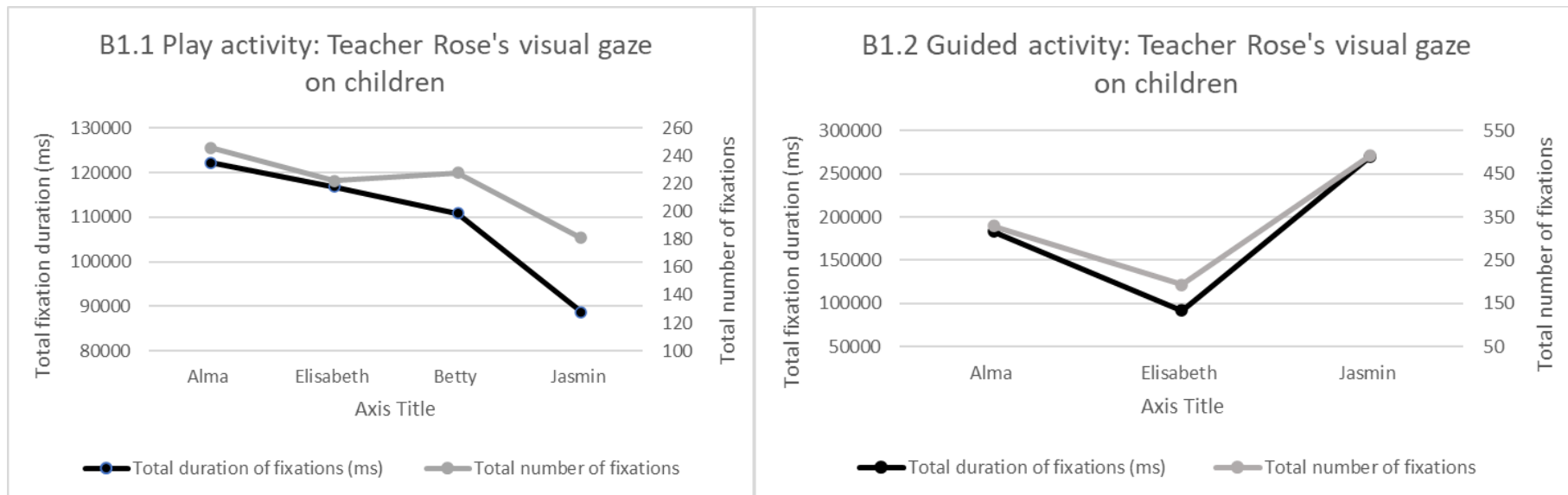

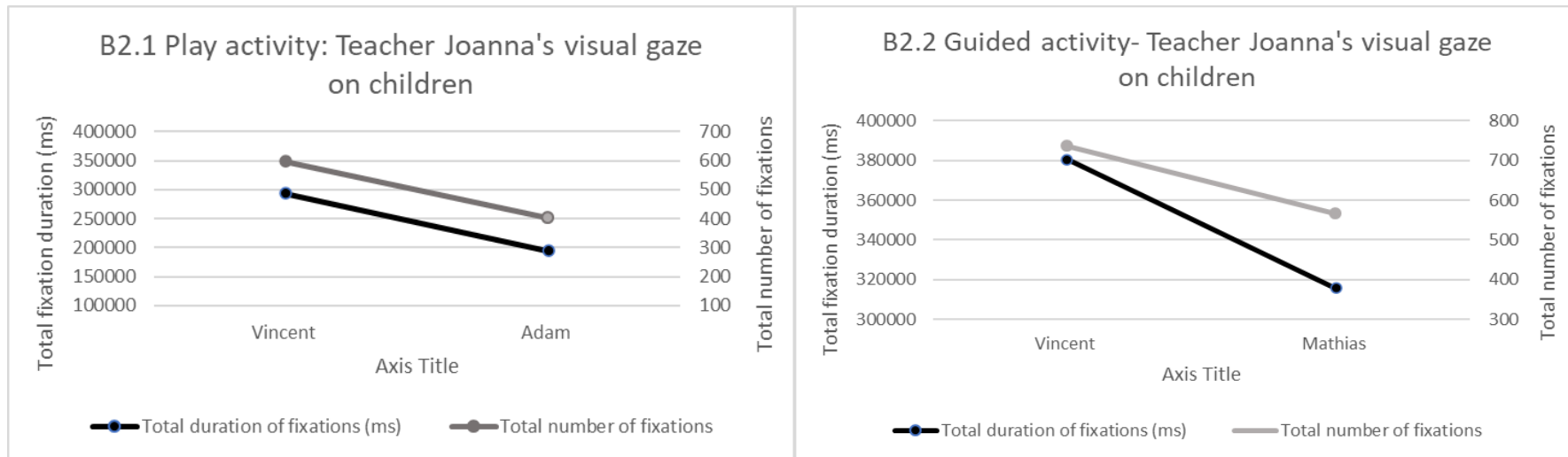Figure B1. Teacher Rose's visual gaze on children in play and guided activities

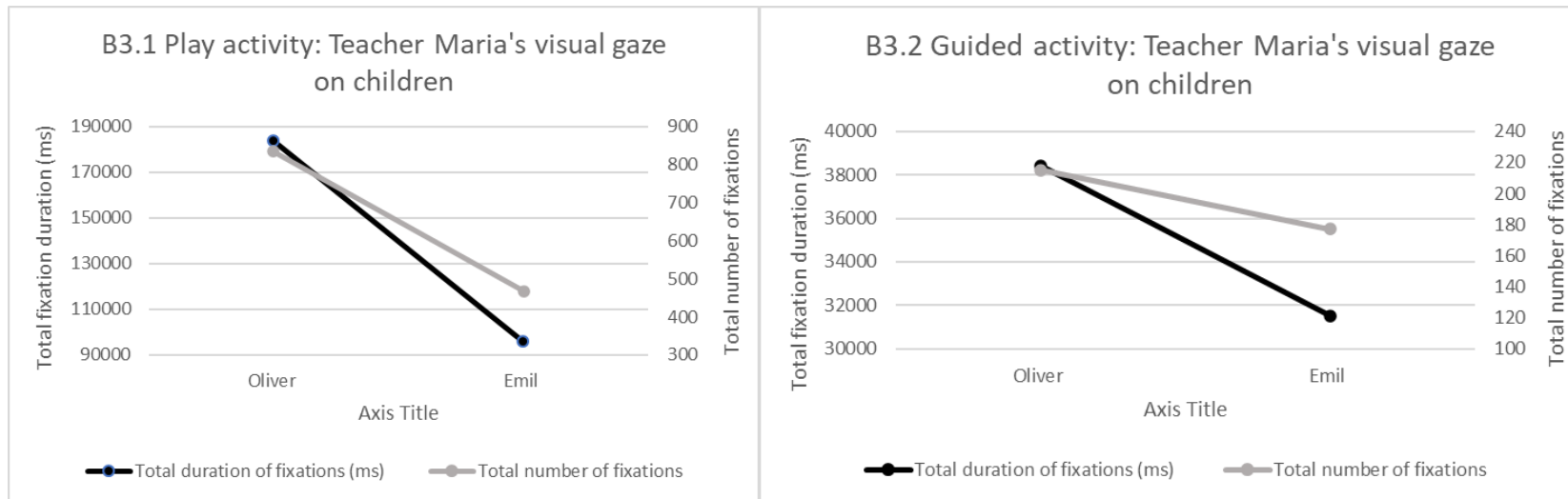*Figure B2. Teacher Joanna's visual gaze on children in play and guided activities*

Figure B3. Teacher Maria's visual gaze on children in play and guided activities

Appendix- C

In Appendix-C, the instructions for the Retrospective Think Aloud (RTA) given prior to showing the eye tracking recording to the participant are presented.

Instructions given to the ECEC teachers by the researchers:

"*Here is a recording of your eye movements and activity recorded by the eye movement camera. I'll show it to you now. Watch the video and tell me what you thought during this teaching and guidance situation. Explain why you acted in that way. If you want to stop the recording, press the space key. To continue, press the space key again. If you do not speak for a long time, I will remind you by saying, 'You can continue speaking.'*"

While showing gaze metrics in the form of bar graphs to the teachers, the following question was asked to evoke their reflections related to their pedagogical actions from their visual gaze:

"*What kind of thoughts do these diagrams evoke for you?*"

The list of questions asked during semi-structured interview. From the list are excluded those questions, which are used in the other forthcoming studies.

1. *"How did you experience the video recording situation?"*
2. *"Were there any surprises while watching the eye tracking video? If so, what kind?"*
3. *"Was there anything in the eye tracking video that would make you change your actions?"*

These questions and seeing the bar graphs inspired teachers to ponder explanations of their visual gaze towards certain children. They also referred to their own or children's actions during pedagogical activities, to reason their visual gaze.