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Title: Early Childhood Education and Care Teachers' Gaze Behavior Across Pedagogical Episodes in Toddler Groups in Finland

Year: 2024

Version: Published version

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Please cite the original version:

Isotalo, S., Ukkonen-Mikkola, T., Lämsä, J., & Rutanen, N. (2024). Early Childhood Education and Care Teachers' Gaze Behavior Across Pedagogical Episodes in Toddler Groups in Finland. *International Journal of Early Childhood*, Early online. <https://doi.org/10.1007/s13158-023-00387-6>



Early Childhood Education and Care Teachers' Gaze Behavior Across Pedagogical Episodes in Toddler Groups in Finland

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Accepted: 16 December 2023
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Abstract

Teacher–child interaction is central in pedagogical activities in early childhood education and care (ECEC). In these activities, teachers' visual gaze is a valuable tool for communication, but this has received little attention in ECEC research. Recent technological advancements in eye-tracking provide an approach to take a deeper look at how teachers focus their visual gaze during activities. Our study focused on three ECEC teachers' visual gaze behavior during pedagogical activities in a group of children under three years of age (later toddlers) in Finland, to gain understanding of how teachers use their gaze to facilitate interactions and pedagogy. The data were collected using eye-tracking glasses in two types of activities: play and guided activity. From these eye-tracking recordings, we identified pedagogical episodes (e.g., guidance). To analyze teachers' visual gaze behavior, we also coded the fixations to the different areas of interest (e.g., teaching materials). The findings showed that the teachers' aim for interaction with children was associated with their visual gaze behavior on teacher- and child-initiated episodes. Moreover, the activity's structure and the teacher's position also played a role in how teachers focus their visual gaze. In this article, we also discuss the potential of eye-tracking technology in reflection of practices implemented in ECEC and we argue that the use of eye-tracking technology is an area that merits further exploration.

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Keywords Toddlers · Pedagogical activities · Interaction · Teacher's gaze · Eye-tracking

Résumé

L'interaction enseignant-enfant est au coeur des activités pédagogiques d'éducation et d'accueil de la petite enfance (ECEC). Dans ces activités, le regard visuel des enseignants est un outil de communication précieux, mais cela a reçu peu d'attention dans la recherche sur l'ECEC. Notre étude s'est concentrée sur le comportement du regard visuel de trois enseignants d'ECEC lors d'activités pédagogiques dans un groupe d'enfants de moins de trois ans (plus tard des tout-petits) en Finlande, afin de comprendre comment les enseignants utilisent leur regard pour faciliter les interactions et la pédagogie. Les données ont été collectées à l'aide de lunettes de suivi oculaire dans deux types d'activités : le jeu et l'activité guidée. À partir de ces enregistrements de suivi oculaire, nous avons identifié des épisodes pédagogiques (par exemple, l'orientation). Pour analyser le comportement du regard visuel des enseignants, nous avons également codé les fixations sur les différents domaines d'intérêt (par exemple, le matériel pédagogique). Les résultats ont montré que l'objectif d'interaction des enseignants avec les enfants était associé à leur comportement de regard visuel lors des épisodes initiés par l'enseignant et l'enfant. De plus, la structure de l'activité et la position de l'enseignant ont également joué un rôle dans la manière dont les enseignants focalisent leur regard visuel. Dans cet article, nous discutons également du potentiel de la technologie de suivi oculaire en fonction des pratiques mises en oeuvre dans les services d'éducation et d'accueil de la petite enfance et nous soutenons que l'utilisation de la technologie de suivi oculaire est un domaine qui mérite une exploration plus approfondie.

Resumen

La interacción maestro-niño es central en las actividades pedagógicas en educación y atención a la primera infancia (ECEC). En estas actividades, la mirada visual de los docentes es una valiosa herramienta de comunicación, pero ha recibido poca atención en la investigación de ECEC. Los avances tecnológicos recientes en el seguimiento ocular brindan un enfoque para observar más profundamente cómo los maestros enfocan su mirada visual durante las actividades. Nuestro estudio se centró en el comportamiento de la mirada visual de tres profesores de ECEC durante actividades pedagógicas en un grupo de niños menores de tres años (más tarde, niños pequeños) en Finlandia, para comprender cómo los profesores utilizan su mirada para facilitar las interacciones y la pedagogía. Los datos se recogieron mediante gafas de seguimiento ocular en dos tipos de actividades: juego y actividad guiada. A partir de estas grabaciones de seguimiento ocular, identificamos episodios pedagógicos (por ejemplo, orientación). Para analizar el comportamiento de la mirada visual de los profesores, también codificamos las fijaciones en las diferentes áreas de interés (por ejemplo, materiales didácticos). Los hallazgos mostraron que el objetivo de los maestros de interactuar con los niños estaba asociado con su comportamiento de mirada visual en los episodios iniciados por los maestros y los niños. Además, la estructura de la actividad y la posición del profesor también influyeron en cómo los profesores enfocan

su mirada visual. En este artículo, también discutimos el potencial de la tecnología de seguimiento ocular como reflejo de las prácticas implementadas en ECEC y sostenemos que el uso de la tecnología de seguimiento ocular es un área que merece una mayor exploración.

Introduction

Early childhood education and care (ECEC) teachers are required to have the expertise necessary to provide individualized attention and support and align pedagogy for every child to support children's individual development (Buysse et al., 2009; Mutiara et al., 2020). Interactional relationships are crucial to fulfilling the child's basic need for attachment as well as to support the child's communication skills and association experiences (Rautamies et al., 2018). Various research has been pursued to clarify factors that improve children's well-being, growth, and development in ECEC (see Guedes et al., 2020; Thomason & La Paro, 2009), and these are usually linked to the quality of teacher–child interaction. In the ECEC field, interaction is an important part of teachers' pedagogical expertise (Ukkonen-Mikkola & Fonsén, 2018), and teachers' visual gaze has been shown in earlier studies as being related to maintaining meaningful interaction between the teacher and the child (Pfeiffer et al., 2013). Teacher–child interactions involve the aspects of emotional support, classroom organization, and instructional support (Pianta et al., 2008). The teacher has an important impact on, for example, the development of children's learning motivation and self-regulation skills (Pakarinen et al., 2010; Salminen et al., 2021), the fostering of students' social and emotional functioning (Hamre et al., 2013), and the reduction of problem behavior (Curby et al., 2013). Hamre et al. (2013) suggested that the primary tool to promote developmental outputs is the quality of interaction between children and adults.

Teachers' visual gaze has proven to play a significant role in observing, predicting, and making decisions related to classroom situations (e.g., Tatler et al., 2014). In educational research, teachers' visual gaze has been studied with new methodological and technological tools (see Goldberg et al., 2021; Jarodzka et al., 2017; McIntyre et al., 2022; Muhonen et al., 2020; Wolff et al., 2020), but the focus on visual gaze is a relatively new area on studies in the ECEC field (Sadamatsu, 2022). In school settings, eye-tracking technology have been earlier used to examine teachers' visual gaze behavior related to their work experience (see Huang et al., 2021; van den Bogert et al., 2014), and distribution of visual focus of attention during teaching (see Chaudhuri et al., 2022; Dessus et al., 2016; Goldberg et al., 2021; Haataja et al., 2020; Keller et al., 2021).

In previous research, infant–toddler pedagogies have received less interest than pedagogies with older children. However, the growing number of infants and toddlers participating in ECEC has increased the need for research related to pedagogy in these groups (Rutanen & Hännikäinen, 2019; Sumsion & Harrison, 2014). In this study, with eye-tracking technology, we explored ECEC teachers' visual gaze behavior in teacher–child interactions during pedagogical activities in toddler groups in Finland.

Pedagogical Activities in ECEC

In the ECEC context, pedagogical activities are considered an important part of supporting children's well-being, agency, and development of both their emotional functioning and learning skills. We have adopted Broström's (2006) three dimensions of ECEC: care, upbringing, and teaching, which ECEC teachers can provide to children simultaneously. For example, the needs of individual children affects the intensity of the care dimension. These needs are evaluated based on silent reflection by the teacher, and from moment-to-moment teachers need to adapt their outputs on these dimensions (Rutanen & Hännikäinen, 2017).

Pedagogical activities performed in ECEC can be seen as a wide range of actions in which toddlers engage throughout the day (Guedes et al., 2020). Play and educational activities have been proven to support a child's engagement in higher quality processes and to offer the best potential for the teacher to provide support for the child in learning and development as well as on an emotional level (Slot et al., 2016). In play, the teachers' role is to observe children's cues, aligning with children's initiations, and to be emotionally available to support children's contributions to play (Hakkarainen et al., 2013). Guided activities are seen as joint activities co-constituted by participants' responsive actions (Wallerstedt et al., 2022) in which a child's development of science-, language-, or math-oriented skills are supported. In this study, despite the slightly divergent functions of the teacher's role in the activities, both guided activity and play are seen important parts of pedagogical activities in ECEC groups, which can include the aspects of care, upbringing, and teaching simultaneously.

Teacher–Child Interactions during Pedagogical Activities

Teachers need interaction-related expertise to perform pedagogical activities, share knowledge, support, and evaluate children during activities (Mutiara et al., 2020). By listening and considering children's expressions and by sharing the same frame of reference in activities with consistency, the teacher enables children to develop their communication skills (Wallerstedt et al., 2022). Moreover, ECEC teachers need expertise to evaluate and support each child's development individually. ECEC teachers' expertise includes aspects of personal values and epistemologies, beliefs about learning and knowledge, and perceptions of the children (Lunn Browlee et al., 2016). In addition, ECEC teachers' expertise is associated with planning, implementing, evaluating, and developing pedagogical activities (Kangas et al., 2015) and comprehensive understanding of the curriculum (Schachter et al., 2021). Many of these require interaction skills, and this way interaction also relates to teachers' pedagogical expertise and classroom management skills (Hamre et al., 2013). A quality of teaching practices and teacher's classroom management skills are associated with better self-control skills, higher on-task behavior, and levels of engagement in learning activities for children (Rimm-Kaufman et al., 2009), and these qualities relate to the cognitive, language, and social–emotional skills of children (Mashburn et al., 2008).

Moreover, teacher–child interaction in a classroom is vital to successfully perform teaching practices (Hamre et al., 2013). During the day, interactions and their quality vary across different activities. During free play and early academic skills activities, interaction was found to be of higher quality than, for example, during mealtimes (Guedes et al., 2020). High-quality interactions between teachers and young children have been associated with two key factors: teachers' heightened sensitivity to children's initiations and ability to effectively conduct the group. In the ECEC, most of the decisions about teacher–child interactions are made based on observation, facial expressions, bodily gestures, and tone of voice (Mofrad, 2012). Moreover, teachers' visual gaze has proven to play a significant role in detecting and maintaining teacher–child interaction (Pfeiffer et al., 2013). Thus, teacher–child interaction is an important aspect of teachers' expertise, where teachers' gaze is linked to maintaining and evaluating communication and effective mentoring of the group.

Teacher's Gaze in Pedagogical Activities

Teachers use their visual gaze to improve their situational awareness by observing and detecting classroom events (Wolff et al., 2020), but also to signal and express intentions and support classroom interaction. If visual gaze is missing or moving, it can interrupt or even obstruct meaningful interaction episodes (Pfeiffer et al., 2013). The quality of interaction can have an influence on the teacher's visual gaze behavior. For example, on a study conducted on first grade, it was found that more students receive visual attention during high-quality educational dialog than during moderate-quality dialog (Muhonen et al., 2020). Moreover, study implemented in secondary school showed that teachers increased eye contact with students when giving directions (Haataja et al., 2020).

The teacher's visual gaze also varies depending on what they would like to express. During questioning, teachers showed dominance by increasing eye contact with students and friendliness by increasing eye contact during lectures (McIntyre et al., 2020). Moreover, teachers can pay more visual attention to children who show more interactive or disruptive behavior (Goldberg et al., 2021) and to children who have challenges concentrating on tasks (Seidel et al., 2021). The results on a study of ECEC teachers' visual gaze behavior related to teachers' possible implicit biases revealed that race and sex of child can have influence on how teacher focus their visual gaze, by increasing teachers gaze especially toward Black boys, when they expect challenging behavior (Gilliam et al., 2016). In addition, during snack time, experienced ECEC professionals looked less at children's faces than other areas (Ishibashi et al., 2020), and when monitoring play situations, the experienced teachers gazed at children more frequently but for shorter times (Sadamatsu, 2022). A study combining ECEC teachers' visual gaze and their reflection of the activity showed that awareness of visual attention can help teachers to reflect their actions (Ukkonen-Mikkola et al., forthcoming). Kidwell and Reynolds (2022) studied gaze using conversational analysis (CA). According to their research, gaze is used as a distinct, tangible way of indicating to others that there is something interesting in their shared environment. In ECEC settings gaze can be used this way, for example, while teacher directs children's attention in pedagogical

activities. Overall, when interpreting children's behavior and providing guidance and support, visual gaze has a vital role. Despite the recent advancements in unobtrusive eye-tracking technologies, little is known about how ECEC teachers use their visual gaze when supporting interaction and children's learning.

Dividing Pedagogical Activities via Teaching Dialog Patterns

Teaching is strongly related to pedagogical activities, and language plays a significant role in combining the teaching, learning, and cognitive development of students (Min-Young & Wilkinson, 2019). Language in teaching can be defined through teaching dialog, wherein the teacher should provide students with a shared responsibility for discussion, ask questions, and provide feedback that will prompt further exploration (Reznitskaya et al., 2009). Teaching dialog also consists of considering students' ideas and requesting explanations for them, supporting collaboration and collaborative interaction through exploratory talk, and paying attention to students' questions (Mercer & Dawes, 2008). We are using Muhonen et al. (2016) approach to dialogic teaching patterns to explore teachers' visual gaze behavior in more specific episodes during pedagogical activities. Muhonen et al. (2016) divided dialog into two sub-patterns: teacher-initiated and child-initiated patterns. In teacher-initiated patterns, teachers maintain and lead dialog, and in child-initiated patterns, they support children's initiatives. Since in toddler groups, the teacher is seen as the primary facilitator for maintaining and supporting children's interactions. Therefore, in this study, teaching dialogs are used to divide teachers' verbal communication into episodes, while they are supporting young children's verbal interaction. Moreover, we are using these diverse phases of pedagogical activities to study teacher's visual gaze behavior.

Aim of the Study and Research Questions

Our aim was to investigate teachers' visual gaze behavior in pedagogical activities to gain a deeper understanding of the ways in which teachers use their visual gaze to facilitate interactions and pedagogy with toddlers. First, we aimed to identify the diverse types of episodes in pedagogical activities. Second, our aim was to explore visual gaze behavior in these episodes. We proposed the following research questions (RQs):

RQ1. What kinds of pedagogical episodes can be identified from pedagogical activities in ECEC groups?

RQ2. How does teachers' gaze behavior appear in diverse types of pedagogical episodes?

Method

Participants, Data Collection, and Data

Three Finnish ECEC teachers participated, and the study was implemented in their small groups of children under three years of age. Participants were recruited through

the cooperation networks of the University of Jyväskylä. All participants worked in the same ECEC center. The ECEC center leader and the teachers were informed of the study and their willingness to participate was inquired beforehand. When performing research practices especially with young children researchers need to ensure space for everyone to comment, to show their views and these need to be heard and considered (Rutanen et al., 2021). On this study, ethical considerations were carefully deliberated, and the study was submitted to review of the ethical board of the University of Jyväskylä. Moreover, a consent form and information sheet were provided to all participating teachers and children's parents and assent to study was negotiated with the children involved before and during research. When children's permission to collect data was acquired beforehand, participating teacher got the chance to test eye-tracking glasses in the presence of participating children. This was done to get participants familiar with the glasses and to minimize possible stress, anxiety or uncomfortable feelings regarding data collection and glasses. Participants were given the opportunity to withdraw from the study at any time. During data collection, researchers were monitoring children's bodily and verbal gestures. Researchers were ready to withdraw from the data collection if some child had shown verbal or non-verbal gestures of feeling uncomfortable in a situation (e.g., crying, hiding, squirming). In reporting the results, pseudonyms of participants have been used.

The participating teachers had completed their bachelor's degree in early childhood education. The participating teachers' work experience was for Maria, one year three months, for Rose, two years three months, and for Joanna, four years. In the groups participating in the data collection, there were from two to four children at a time (Table 1). In Maria's case, the small group of children were the same in both of the data collection situations. In Joanna's and Rose's case, some children were present in both situations, but not all. There were in total nine children participating: five boys and four girls. The participating children's ages ranged from 29 to 36 months, with an average of 31 months.

Data were collected with Tobii Pro Glasses 2 (<https://www.tobii.com/>) that are mobile and unobtrusive eye-tracking glasses, allowing capturing participants' eye-movement data in authentic environments. Eye-movement data include participants gaze fixations (period where visual gaze is relatively still), saccades (rapid eye movements between fixations) and blinks. In addition to the eye-movement data, these eye trackers record video and audio data of participants' actions, enabling multimodal data analysis. For this study, we used only participants fixation data in terms of total duration of fixations. Total duration of fixations is defined as total amount of time that measured gaze is focusing on specific area of interest (AOI) (more information of eye-tracking technology: Holmqvist et al., 2015). Eye-tracking glasses were calibrated by the researcher and participating teacher before the recording using one-point calibration (Tobii Pro, 2023), and the calibration was verified with the three-set point technique (Muhonen et al., 2020). The data included two eye-tracking recordings from each participating teacher: one from play and one from guided activity. The teachers chose the content of the play and guided activities. Play activities consisted of elements from guided play, where the teacher chose timing of the activity and toys, and from free play, where the children were free to play

Table 1 Specific features of the guided and play activities

Teacher	Activity	Specific features of space and organization of the activity	Length of the recording
Rose	Guided activity, music	3 children, teacher sitting in front, children on their specific sitting platforms	15:31
Maria	Guided activity, music	2 children, teacher sitting in front, children on their specific sitting platforms	12:10
Joanna	Guided activity, fingerpaint art	2 children, children sitting around table, teacher moving	31:45
Rose	Play activity, Legos	4 children, children sitting or moving around the table, teacher sitting on the floor, spacious room	16:18
Maria	Play activity, magic sand, and molds	2 children, children and teacher around table, teacher sitting and children standing (table designed to be on children's level)	32:02
Joanne	Play activity, wooden train track, trains	2 children, children and teacher on a floor, teacher as assistant, children moving while building the train track	19:46

following their own ideas and creativity, in the presence of the teacher (Weisberg et al., 2013). Guided activities were conducted via music or art. More specific features of the organization of the guided and play activities can be seen from Table 1.

The lengths of the eye-tracking recordings are presented in Table 1, and the recorded data in total were 127 min and 32 s. The length of the individual recording equals the length of the activity. Technical difficulties affected the duration of one video by ending the recording one minute early. We still included this recording because the gaze sample percentage (the total percentage of time when at least one or both eyes were detected) was over 70% (Chaudhuri et al., 2022; Muhonen et al., 2020). The gaze sample percentage on all recordings ranged from 74 to 94%, and our data consisted of all six recordings. The gaze sample percentage was never 100% because of natural causes such as blinking the eyes (Holmqvist et al., 2015). The eye-tracking videos also included audio from the interactions between the teacher and children, thus allowing these recordings to address RQs 1 and 2.

Data Analysis

To answer our first RQ, eye-tracking recordings of pedagogical activities were first viewed several times. While watching, we identified pedagogical episodes using features of dialogic teaching patterns (Muhonen et al., 2016). Two researchers discussed the interpretations of the differences and commonalities in terms of the interactional initiatives and features in different pedagogical episode types. An episode was defined as the continuous verbal exchange between the children and teacher on the same topic (Muhonen et al., 2020). In our study, a new topic initiated by a teacher or child through dialog along with their verbal and/or bodily actions started a new pedagogical episode. To label identified episodes based on their common features, we used teachers' physical or verbal actions in the specific episodes. In our study, we referred to all these episodes as *pedagogical episodes*.

To answer our second RQ, we relied on eye-tracking metrics in terms of fixations, to measure teachers visual gaze behavior (Lämsä et al., 2022). From fixation data, total duration of fixations was used to explore teachers gaze behavior in the diverse types of pedagogical episodes. The eye-tracking recordings were analyzed using Tobii Pro Lab v. 1.171 software. First, teacher- and child-initiated episodes were manually coded on eye-tracking recordings as times of interest (TOIs) based on the pedagogical episodes identified. This allowed the recorded data to be divided into specific intervals in which meaningful behaviors and events took place (Holmqvist et al., 2015). After this, we identified essential AOIs from the eye-tracking recordings. Table 2 shows how AOIs were formed and that AOIs were targets in the surroundings, such as children and playing/teaching materials, toward which the teacher focused their visual gaze during pedagogical activities (e.g., Chaudhuri et al., 2022; Muhonen et al., 2022). Teaching and playing materials were combined in one AOI, as it was more relevant to know for how long the teacher gazed at the materials overall, instead of how long they focused their visual gaze on each individual toy. However, every child was considered as an individual AOI (child 1, child

Table 2 Areas of interest (AOIs) in the study

Content of AOI	How AOI is defined	Name of the AOI
Individual children	Every child was coded as an individual AOI in every activity	Child 1, child 2, child 3 and child 4
Paints, instruments, trains, magic sand, or Legos	All teaching/playing materials in one activity were coded in this AOI	Teaching/Playing materials
Walls, windows, floors, etc.	All targets not related to implementing the activity were coded into this AOI	Others

2 child 3 and child 4) in each activity, as it was important to gain knowledge of how long the teacher focused their visual gaze on each of them.

Second, we manually coded the teachers' fixation data onto the different AOIs set as stationary pictures in the Tobii Pro Lab. The coding was done fixation by fixation by clicking AOI in the stationary picture on which the teachers' gaze focused during the eye-tracking recording (Lämsä et al., 2022). Third, we collected eye-tracking metrics related to the duration of teachers' fixations on AOIs. Fourth, because the length of pedagogical episodes varied, both for teachers and between teachers, we transformed the total duration of teachers' gaze fixations from milliseconds to percentages. This allowed us to calculate the proportion of time that teachers gazed on specific AOIs relative to the total duration of fixation during the episode type in question. By using percentages, we could analyze teachers' gaze behavior across diverse types of episodes. Fifth, we presented the data using visual representations in the form of tables, which showed the percentages of fixation durations of teachers' visual gaze on specific AOIs, during different pedagogical episodes.

Inter-coder reliability was checked by double coding 20% from the entire dataset in terms of AOIs in eye-tracking videos. Inter-coder reliability was assessed using Cohen's kappa, which was calculated from the time series data (i.e., 50 data points per second). These coefficients were used to evaluate the level of agreement between the two coders separately for each AOI. We set 0.7 as a threshold value of Cohen's kappa to indicate good reliability (Lämsä et al., 2022). In our study, Cohen's kappa was >0.77 for all the AOIs, indicating substantial agreement between the two coders.

Findings

Pedagogical Episodes Identified

As an answer to our first research question, 190 episodes related to teaching dialog in pedagogical activities were identified. Of these, 108 were teacher-initiated episodes, and 82 were child-initiated episodes. From these three teacher-initiated pedagogical episode types, *guidance* ($f=66$), *invitation* ($f=14$) and *safety* ($f=28$) and two child-initiated pedagogical episode types, *enabling* ($f=56$) and *monitoring* ($f=26$), were identified. Table 3 presents all episode types and incidence of episodes per teacher in play and guided activities. A teacher-initiated *guidance* episode included the teacher preparing an activity or the next step of the activity, showing an example, asking the children questions related to the theme of the activity, getting the children's attention, or showing something to them, encouraging them to continue, praising them, and verbalizing actions for the children. In teacher-initiated *invitation* episodes, the teacher verbally invited children back to the ongoing activity if the children got distracted. Teachers could also give some options to children that they could choose themselves, for example, to first slide down the slide and then continue the activity. Invitation could also be done bodily, for example, by steering the child by holding their hand. Teacher-initiated *safety* episodes relate more to the care aspect of ECEC. For example, accompanying a child to the toilet was involved

Table 3 Pedagogical episodes in play and guided activities

Teacher	Episode	Number of episodes in guided activity	Number of episodes in play activity
Rose	Guidance	5	12
Maria	Guidance	7	15
Joanna	Guidance	15	12
Rose	Invitation	1	10
Maria	Invitation	2	0
Joanna	Invitation	0	1
Rose	Safety	1	9
Maria	Safety	1	9
Joanna	Safety	7	1
Rose	Enabling	4	9
Maria	Enabling	3	17
Joanna	Enabling	12	11
Rose	Monitoring	5	5
Maria	Monitoring	0	6
Joanna	Monitoring	7	3

in activities, because of their age. These also included situations where a child sat on the teacher's lap or where the teacher helped children get dressed, for example, by putting on their socks. Restraining and limitations, for example child not to throw toys, were also part of this episode type.

In child-initiated *enabling* episodes, the child started the episode by asking something or showing something. The teacher enabled the child's communication initiative by asking further questions of the child, showing interest in the child's initiative, or giving space for the child to further explain themselves. The teacher expressed that she was available for the child by showing interest and actively supporting interaction. All child-initiated *monitoring* episodes did not include much dialog between the teacher and children. These episodes included situations where one or more children were anxious or tired and focused their attention on something other than on going activity. In these episodes, the initiative from the child could be done bodily or verbally, for example, the child running away and then initiating verbally by asking the teacher to look at how fast she was running. Teachers monitored these children running but might have interacted verbally with other children or asked what the distracted child was doing.

When looking at the total number of pedagogical episodes and their specific features, such as the activity's structure and the teacher's position, these may have played a role in the number of observed pedagogical episodes. For example, Rose's play activity was in spacious room (Table 2) and in this activity, there were more *invitation* episodes than in other activities (Table 3). In this activity, the children moved a lot even though the actual activity was quite stable Lego play around the table. Strictly structured activities where children had their designated places to sit (Rose and Maria, guided activities) seemed to decrease *monitoring*, *enabling*,

invitation, and safety episodes (Table 3). In these cases, the activity was related to music and the children were sitting on their own specific sitting platforms with the teacher sitting in front of them. Teachers being positioned next to the children (Rose, Joanna, and Maria, play activities) and being able to move next to the child when the children are sitting in their places (Joanna, guided activity) seemed to increase the number of enabling and guidance episodes (Table 3).

Teachers' Gaze Behavior in Pedagogical Episodes

To answer our second research question, we examined teachers' gaze metrics related to specific AOIs in pedagogical episodes. In the following, we will present teachers' visual gaze behavior in different pedagogical episodes in terms of total duration of gaze fixation percentages on specific AOIs.

Teachers' Gaze in Teacher-Initiated Pedagogical Episodes

Commonly, in teacher-initiated pedagogical episodes the teacher focused their visual gaze towards different AOIs accordingly, what themselves were expressing verbally, or on what they wanted children to focus their attention to. As Fig. 1 indicates, in teacher-initiated guidance episodes, teachers' gaze during play activity was mostly more on AOI of playing materials than on AOIs of the individual children. Moreover, when looking at the teachers' visual gaze in guided situations, the teachers' gaze varied more between different AOIs but was fixed more often on the AOIs of the individual children.

In all play activities and Joanna's guided activity, where the teacher was positioned sitting next to the children on their level, the focus of their gaze was more on playing materials (Fig. 1). In these episodes, the teacher focused the children's attention on the activity at hand by engaging themselves in and their visual gaze on the activity and by verbalizing and showing examples. Guided music for Rose

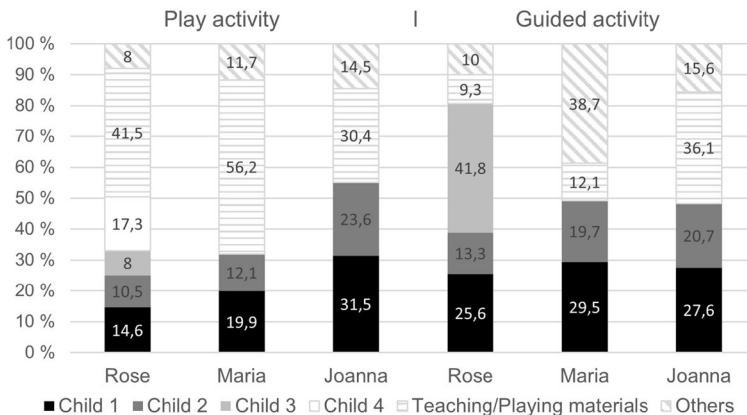


Fig. 1 Teachers' gaze fixation duration percentages on specific AOIs in teacher-initiated guidance episodes

and Maria was more structured, and the teacher was clearly sitting in front of the children. On these occasions, the teacher's gaze focused mainly on children sitting in front of the teacher in their assigned places.

Figure 2 indicates that in teacher-initiated *invitation* episodes during play activity, the teachers' visual gaze was mostly on AOIs of the individual children, but when looking at the guided activities, teachers gazed more on the AOI of others.

In play activities, teachers focused their visual gaze on the child that they were inviting back to the activity or whose participation they were supporting verbally (Fig. 2). Guided activities, in which invitation episodes were detected, were both music activities. In these, children were not moving around very much, so usually these contained the teacher's invitation for the child to come and sit in their place and focus their attention on the ongoing activity. In these situations, if a child was moving, the teacher verbally invited them back but focused their visual gaze between the child and the AOI of others, which, in this case, was usually the child's specific sitting platform.

Figure 3 indicates that in teacher-initiated *safety* episodes, the teachers' visual gaze during play activity was typically more on AOIs of the individual children than other AOIs. This also applied mainly to guided activities.

Teachers focused their visual gaze on the child they were giving instructions to, asking questions, or whose physical safety they were concerned about. This is also shown in Fig. 3, where the gaze percentages of individual children are mostly higher than those of other AOIs. The most notable exception was Maria's guided activity, where the major safety-related situation was the teacher asking about the child's need to go to the toilet. During these inquiries, Maria looked at the door where the toilet was, and showed the child with the focus of her visual gaze in which direction they should move if needed.

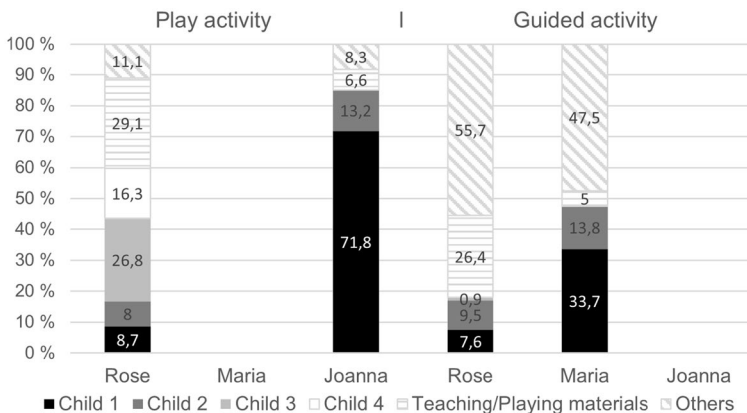


Fig. 2 Teachers' gaze fixation duration percentages on specific AOIs in teacher-initiated invitation episodes (the missing column indicates that this episode type was not detected in this activity)

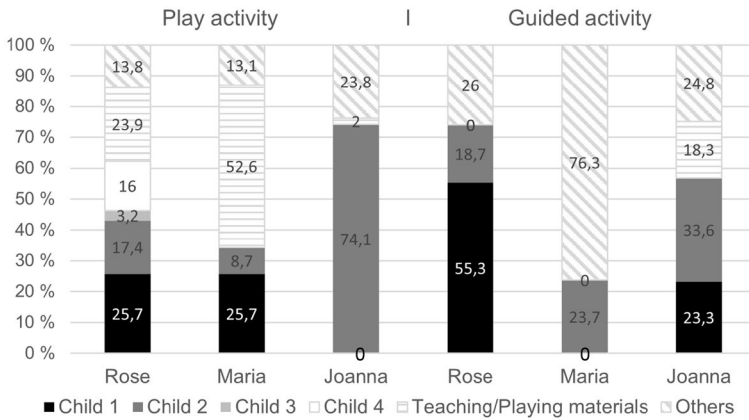


Fig. 3 Teachers' gaze fixation duration percentages on specific AOIs in teacher-initiated safety episodes

Teachers' Gaze in Child-Initiated Pedagogical Episodes

Commonly in child-initiated pedagogical episodes the teacher's visual gaze moved between AOIs of the individual children and AOIs of teaching or playing materials. However, being in general more often on individual children. Figure 4 of child-initiated *enabling* episodes shows that during play activities, teachers' visual gaze was mostly on AOI of the playing materials. During guided activities, teachers' visual focus of gaze was more on AOIs of the individual children than other AOIs.

In all play activities and Joanna's guided activity, the teacher was positioned sitting next to the children, and the focus of their visual gaze was mostly on playing or teaching materials (Fig. 4). In these situations, the teacher's visual gaze was more on what the child was showing or talking about, and the teacher showed engagement

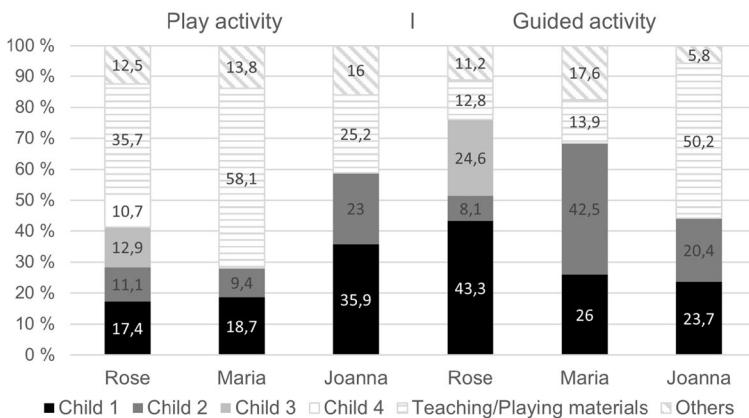


Fig. 4 Teachers' gaze fixation duration percentages on specific AOIs in child-initiated enabling episodes

in the child's interest by verbally acknowledging it and focusing their visual gaze on it. In the structured guided music activities of Rose and Maria, the position of the teacher in front of the children and fewer teaching materials being used in the activity increased the focus of visual gaze on individual children in the enabling episodes.

Figure 5 shows that in the child-initiated *monitoring* episodes in play activities, the teachers' visual gaze was mostly on AOIs of the individual children. During guided activities, the teachers' focus of visual gaze varied between AOIs of the individual children and the AOI of the teaching materials.

In these episodes, teachers monitored with their visual gaze children who were distracted, and as shown in Fig. 5, the teacher focused their visual gaze mostly on these children. In Maria's play and Joanna's guided activity, the teachers' visual gaze was more on teaching or playing materials. In these situations, children were sitting around the table with the teacher, and even when they got distracted, they stayed relatively still. The teacher's visual gaze was more on teaching or playing materials, when they tried to engage the child in the activity using their gaze. Moreover, the focus of teachers' visual gaze on individual children was still quite consistent in these situations.

Discussion

With this study, we aimed to clarify teachers' visual gaze behavior, while facilitating interactions and pedagogy with young children. This was studied during pedagogical activities in toddlers' groups. First, we presented five pedagogical episode types identified from pedagogical activities: teacher-initiated guidance, safety, and invitation and child-initiated enabling and monitoring. These findings relate to teachers' ability and need in ECEC activities to adapt their instructional approach to the teaching, care, and upbringing when supporting children individually (Rutanen

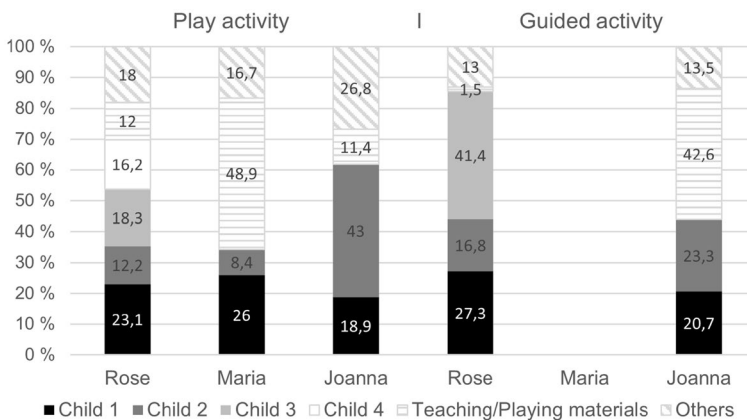


Fig. 5 Teachers' gaze fixation duration percentages on specific AOIs in child-initiated monitoring episodes (the missing column indicates that this episode type was not detected in this activity)

& Hännikäinen, 2017). In toddler groups, teacher- and child-initiated episodes were almost as common, which is in line with earlier results in preschool settings, whereas in primary school, child initiations seemed to decrease (Muhonen et al., 2016). Active dialog between teachers and children can also be related to teachers' expertise in supporting children's participation and providing encouragement for their own initiatives (Salminen et al., 2021; Ukkonen-Mikkola & Fonsén, 2018).

The findings also show a relationship between the activity's structure and the teacher's position in the construction of the pedagogical episodes. Also, teachers' position in front of children in structured guided activities had relationship with child-initiated enabling and monitoring episodes. In these, the teachers' focus was more on classroom organization and instructional support. The position of the teacher next to the children in play and not-so-structured guided activity increased teacher-initiated guidance and child-initiated enabling episodes. These findings are mostly in line with earlier studies where teacher-child interaction was shown to be higher quality in play- and guided activities (Guedes et al., 2020). In addition, our findings suggest that highly structured activities in toddler groups might decrease active initiations from the children.

Findings related to teachers' visual gaze behavior showed that in all pedagogical episode types, teacher aims of interaction influence teachers' focus on their visual gaze. The focus of a teacher's visual gaze can also vary whether the episode is teacher- or child-initiated. In general, in teacher-initiated episodes, the teachers' visual gaze was more on teaching or playing materials. In teacher-initiated guidance episodes, teachers focused their visual gaze on what they wanted to show or express, in safety episodes, on whom they were giving instructions to, and in invitation episodes, on what they wished the child to concentrate. Also, in earlier studies, teachers were seen to provide guidance using their visual gaze (Haataja et al., 2020) and to influence actions in their environment (Tatler et al., 2014). Teachers focusing their visual gaze more on children in child-initiated episodes seem to second the aspect of teacher being sensitive toward children's cues (see Wallerstedt et al., 2022). In enabling episodes, teachers focused their visual gaze on children to non-verbally support and encourage them to interact (see Muhonen et al., 2016). In monitoring episodes, the teachers focused their visual gaze on children who were distracted, which led the teachers to focus their gazes more on children who showed more disruptive behavior (Goldberg et al., 2021). If the teachers' gaze moved more between teaching/playing materials to children in enabling episodes, the teachers visual gaze was on what the children's initiation concerned, and in monitoring episodes, on what they wished children to focus on. Teachers engaged themselves in interaction and paid attention to what the children were initiating, and the focus of the teachers' visual gaze supports this.

Our findings on teachers' visual gaze behavior, related to the structure of the activity and teachers' position, show that the duration and what teachers focus their visual gaze on varies. Teachers' position in front of children in structured guided activities increased teachers' visual gaze toward children in almost all episode types, and this is in line with earlier studies where visual gaze was found to be linked to observing and detecting classroom events to improve teachers' situational awareness (Wolff et al., 2020). An exception was teacher-initiated invitation episodes, where

the teachers' visual gaze was more on the AOI of others. Invitation episodes are linked to the teacher inviting the child to join the activity when the child gets distracted. This finding contrasts with earlier studies in which teachers were found to focus their gaze more on children who had challenges concentrating on tasks (Seidel et al., 2021). Our study indicates that in structured activities when a child needs support on concentrating, teachers may steer the child's focus with their visual gaze. This is done by the teacher by focusing their visual gaze on what themselves want the child to pay attention to, rather than focusing their visual gaze directly on the child.

Limitations, Implications, and Future Directions

There are some limitations to this study. First, the data in this study were collected in authentic ECEC settings where children and the teacher could move freely during the data collection. This leads to some compromises in terms of the quality of the data since we could not control head movement, gaze angle, or lighting (see Tobii Pro, 2020). To maximize the utilization of data gained in data collection, AOIs were first visually recognized from recordings, then named and all fixations from the eye-tracking video recordings were manually coded on to the selected AOIs. In addition, to minimize the influence of eye-tracking glasses on children's and teachers' behaviors, glasses were introduced to all participants beforehand. The second limitation is the small number of research participants. Therefore, generalized conclusions cannot be drawn from the results.

Regardless of the limitations, this exploratory approach involving eye-tracking technology contributes to developing research methods and practices in studies in ECEC with toddlers. With eye-tracking technology, ECEC teacher's visual gaze behavior can be explored in teacher-child interactions and this way gain understanding of the ways that teachers use their visual gaze to facilitate interactions and pedagogy with toddlers. In addition, this study offers better understanding of the role of teachers' visual gaze behavior in pedagogical interaction in authentic ECEC settings and activities. Thus, this study contributes to the literature of eye-tracking research, often conducted in more structured settings like school classes and restricted learning tasks. By examining interaction with eye-tracking in pedagogical activities, we have gained knowledge of how teachers use their visual gaze to support, steer, and engage children in activities and interaction. This knowledge of teachers' visual gaze behavior in interaction can be used and reflected with teachers in developing the ECEC practices.

This study revealed several directions for future research. In future research, more focus could be directed to the teachers' perceptions and reflections of their eye-tracking data and decisions in pedagogical situations. Moreover, gaze data gained through eye-tracking gives more specific information about the focus of visual gaze than video recordings that are often used in interaction analysis. Hence, another future direction could be combining eye-tracking data with more detailed methodologies that focus on the process of interaction, such as conversation analysis (Kidwell & Reynolds, 2022). In addition, it is possible to utilize eye-tracking technology to

identify teachers' visual gaze behaviors related to their years of work experience. In our study, participants were all quite recently started their ECEC career and collecting further data from teachers who have extended work experience would provide an excellent opportunity to study this phenomenon.

Conclusions

Our findings support the importance of teachers using their visual gaze for observing and supporting children's interaction. With respect to implementing pedagogical actions, our findings suggest that teachers can use their visual gaze to show interest, support a child's initiations, and engage children in activity. Additionally, our findings show that the structure of the activity and the teachers' position may influence the incidence of different pedagogical episodes and teachers' visual gaze behavior. For toddler groups in structured activities, the teacher may direct the child's attention by focusing their visual gaze on what they want the child to pay attention to. Therefore, eye-tracking technology offers a methodological tool to study how teachers use their visual gaze in sensitive interactions to successfully engage children in pedagogical activities.

Acknowledgements This study was supported by the University of Jyväskylä, Department of Education. We are grateful for all the ECEC teachers, children, families, and ECEC centers that participated.

Author Contribution All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Susanna Isotalo and Tuulikki Ukkonen-Mikkola. The first draft of the manuscript was written by Susanna Isotalo and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding Open Access funding provided by University of Jyväskylä (JYU). This study was funded by the University of Jyväskylä, Department of Education.

Declarations

Conflict of Interest The authors have no competing interests to declare that are relevant to the content of this article.

Ethical Approval Approval was obtained from the ethics committee of the University of Jyväskylä. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent to Participate Informed consent was obtained from participating teachers and legal guardians of the children. The children's assent to participate in the study was negotiated with the children involved before and during research.

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