



Experienced nursery teachers gaze longer at children during play than do novice teachers: an eye-tracking study

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Abstract

Despite the widespread recognition of the significance of outdoor play in early childhood development, centers for early childhood education (ECE) face the challenge of striking a balance between active play activities and safety concerns. Thus, the visual attention of teachers is critical. Studies that compare the visual attention of novice and experienced teachers traditionally focus on instructional settings instead of recreational play. This study examines the effect of experience on the attentional focus of teachers on children's play in ECE settings in Japan. Eye-tracking data were collected from 10 novices and 10 relatively experienced ECE staff members to compare fixation location, number of fixation, and fixation duration while groups of 3-year-old children played in a sandbox. The results of the independent sample *t* tests revealed that experienced teachers gazed at the children more frequently than did novice teachers; however, the mean fixation duration was significantly shorter among relatively experienced teachers across all participants. Similarly, although experienced teachers spent more time overall than did novice teachers in observing the children and peripheral areas of the play area as they played, the mean fixation duration was significantly shorter than that of novice teachers. The findings support other studies that highlight the heightened ability of experienced teachers to assess conditions more quickly and draw conclusions regarding the activities of children. In addition, the findings support research that reports that the level of supervision and control imposed by ECE teachers on children's play and safety are closely related to their level of experience.

Keywords Eye tracking · Gaze measurement · Teaching experience · Free play · Visual attention

Introduction

Promoting the physical and social forms of play presents a dilemma for providers of early childhood education and care (ECEC), who are simultaneously tasked with nurturing the development of children and ensuring their physical and emotional safety. Scholars repeatedly demonstrate the physical, cognitive, and psychosocial benefits of play. In contrast, ECEC providers must also consider the vulnerability of children to risk and danger outdoors (Elsley, 2004; Sandsester & Sando, 2016; Valentine & McKendrick, 1997). An increasingly risk-averse and litigious environment requires ECEC providers to balance between the need of children for

outdoor enjoyment and the demands imposed by safety regulations and insurance requirements (Copeland et al., 2012; Little & Sweller, 2015). Previous studies illustrate that a few ECEC practitioners are concerned with litigation due to injuries; thus, they are hesitant to allow children to engage in outdoor play and tend to emphasize supervision more than they allow children to freely engage in physical activities (Coleman & Dymont, 2013; Kernan & Devine, 2010).

Certain studies indicate that the levels of supervision and control that ECEC teachers impose on children's play are strongly related to their level of experience. In other words, novice teachers are more likely to intervene in play activities, whereas those with sufficient knowledge and experience are frequently more comfortable and allow children to play more freely (Bubikova-Moan et al., 2019; McInnes et al., 2011). However, such conclusions are typically obtained through qualitative studies that involve interviews. To the best of my knowledge, objective empirical studies that explore the impact of the level of experience of ECEC teachers on the supervision of children's play are lacking.

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Sadamatsu (2021) noted significant differences in the behavior of children when playing in the presence of novice versus relatively experienced ECEC teachers, even when the actions of the teachers were similar. This finding led to the conjecture that although the actions of the teachers were similar, the distinct patterns of children's play could be attributed to differences in teacher gaze, particularly their scan paths. To the best of my knowledge, apart from Ishibashi et al. (2020), who used eye tracking to measure the number and duration of fixation of ECEC staff members on children during snack time and free play, no study has compared visual attention patterns between ECEC teachers with varying levels of experience. Therefore, the current study examined differences in the movement and duration of the scan paths of new and experienced ECEC teachers in Japan. Specifically, this study used eye trackers to measure the number, frequency, and duration of teacher fixation when observing and interacting with a group of children playing in and near an outdoor sandbox. This study contributes to the literature on early childhood education (ECE) by extending studies on the impact of the experiences of teachers on their visual monitoring behavior in the field of children's play.

The following research questions guide data collection and analysis:

RQ1 How (if at all) does the experience level influence the number of fixation, fixation duration, and mean fixation duration of ECE teachers when supervising children at play?

RQ2 How (if at all) do the gazes of novice and experienced teachers differ when looking at the faces and bodies of the children and areas adjacent to play areas during playtime?

RQ3 How (if at all) do novice and experienced teachers differ in the theme of their verbal comments to children (e.g., question, praise, suggestion, and stop)?

What is play?

An important question that emerges when reviewing the literature on play is the definition of the term. The literature is replete with definitions of play that were rooted in various theoretical frameworks, including cognitive developmental theory (Piaget, 1945; Vygotsky, 1967), psychodynamic theories (Freud, 1961), arousal modification theory (Berlyne, 1960; Hutt, 1985), and sociocultural theory (Bateson, 1955; Mead, 1934). Stagnitti (2004) presented an amalgam of modern definitions of play, which can be summarized as fun, unpredictable, pleasurable, safe, internally than externally motivated, transcendent and reflective of reality, player-controlled, attentive to process instead of product, and spontaneous and non-obligatory active engagement.

Although scholars have debated the validity of the above-mentioned sets of characteristics for presenting a full definition of play (Pellegrini & Galda, 1993), the author deems that defining play in the context of the current study is appropriate. The reason is that the study is concerned with the outdoor sandbox play of children in ECEC settings, which can be considered a form of spontaneous "free play" that typically requires observation and supervision instead of active guidance.

Playtime in ECEC settings

Researchers and educators have previously emphasized the importance of play in the social, cognitive, and emotional development of young children. Vygotsky (1967) described play as "the leading source of development" during preschool years (1967), and other early childhood educators and philosophers similarly highlighted play as a core activity for socio-emotional growth (Baines & Blatchford, 2010; Cannella, 2002; Gadamer, 2003; Moyles, 2015; Piaget, 1945).

Other studies have indicated that play provides children with opportunities for creating knowledge (Levin, 1996), regulating events, defining the meaningfulness of objects (Samuelsson & Carlsson, 2008), and learning effective communication, cooperation, negotiation, and socialization with others (Glover, 1999). Moreover, recent research has demonstrated that engaging in outdoor play prior to learning improves executive functions, such as inhibitory control or attention, which results in increased on-task classroom behavior (Lundy & Trawick-Smith, 2021). Accordingly, the United Nations recognizes play as a fundamental human right (OHCHR, 1989), and several countries have prioritized free play in their ECE and development frameworks (Gupta, 2018).

Play in ECEC settings generally occurs under the supervision of adults, who monitor and constrain the activities of children (Kyttä, 2004). Moreover, children frequently seek the approval of adults of their behavior through visual approval or verbal affirmation. Accordingly, the evaluations, assessments, and decisions of supervising adults to allow children to engage in play activities heavily influence the decisions of children during play (Sandseter, 2014). Several studies suggest that the cues children receive from adults during play can positively or negatively impact their behavior and learning (McInnes et al., 2009, 2010; Thomas et al., 2006). Specifically, children who engage in activities under playful practice conditions, which afford them with greater choice, exhibit superior performance and behaviors conducive to learning compared with children under formal conditions, which offer them fewer choices (McInnes et al., 2011). Thus, although adults play a role in ensuring that children are safe when playing, they also represent constraints on the

opportunities of children to experience and overcome risks and challenges (Sandseter, 2014). In this context, several studies emphasize the importance of professional experience and expertise in influencing strategies with regard to when and how to intervene in the free play of children (Hunter & Walsh, 2014; Ivrendi, 2020; McInnes et al., 2011).

A review on ECEC conducted by the Organization for Economic Cooperation and Development (2020) states that two main characteristics distinguish Japanese teachers of nursery schools from their counterparts. First, although few Japanese nursery teachers graduate from 4-year universities, they can only teach after graduating from vocational schools. Moreover, Japanese ECEC teachers must obtain a license to qualify to work in such settings. However, as few teachers graduate from 4-year universities or graduate schools, the majority of them continue their education in the field (at work).

Playtime and academics are integrated into a single set of activities in ECE in Japanese settings. Children in Japan attend nursery schools from infancy to the age of 6 years. According to the Ministry of Education, Culture, Sports, Science and Technology (MEXT, 2008), five goals are set through play, namely, health, human relations, environment, language, and expression. According to MEXT, Japanese ECEC programs aim to cultivate the following areas of foundational knowledge and skills: foundations of thinking, judgment, and expression; and humanity toward learning in preparation for elementary school (MEXT, 2011).

Visual attention in experienced and novice teachers

Eye fixation, that is, maintaining gaze at a single location, is derived from and reflect the capability to visually encode spatially distributed information (Just & Carpenter, 1976). Human eye movements are guided by bottom-up strategies, which emphasize salient, attention-grabbing features, whereas top-down strategies, which are grounded in plans and intentions, are perceived to derive from ingrained knowledge gained through experience (Schütz et al., 2011; Seidel et al., 2020; Shulman, 1987).

Differences in the application of the two strategies have been widely applied to studies that distinguish novice professionals from experts with high levels of professional knowledge. In the field of childhood education, numerous classroom studies have identified differences between the visual attention and information processing of novice and expert teachers. Such comparisons have indicated that expert teachers demonstrate greater gaze efficiency than did novices, as evidenced in their ability to equally distribute their attention across students and move more smoothly from one event to the next (Wolff et al., 2016). For example, Carter et al. (1988) have found that when teachers were presented with slides of children during science and mathematics classes

and asked to discuss their perceptions of visual stimuli, the experts demonstrated an enhanced ability to focus on the actions of students and to interpret subtle cues. Thus, these teachers could form better connections between pieces of information and weigh the relative importance of various pieces of visual information.

Eye-tracking methods have been applied to research in the psychological and neurological sciences for decades. In the field of education, the measurement of eye movements has illuminated the cognitive processes and mechanisms involved in reading comprehension (Raney et al., 2014), and mathematical thinking and learning (Strohmaier et al., 2020), among others.

Eye-tracking technology has also been harnessed to examine professional vision in various settings in the last two decades. Across domains, studies consistently found that the ability of experts to harness such a vision contributes to enhanced attentional skills and increased gaze efficiency, which enables them to focus on relevant versus irrelevant visual information (Charness et al., 2001; Chi et al., 1982; Jarodzka et al., 2010, 2017). In terms of dynamic stimuli, experts tend to engage in fewer, albeit longer, fixation on relevant areas, which suggests an increased understanding of important visual cues, which enables them to employ more selective search strategies (Goldberg et al., 2021; Moreno et al., 2002).

Scholars have confirmed these findings in the classroom setting. For example, Cortina et al. (2015) used mobile eye-tracking technology to compare the eye movements of expert and novice teachers during teaching. The authors found that novice teachers tended to fixate more on specific students, whereas experienced teachers could monitor the entire class. Similarly, a study by Dessus et al. (2016) on the gaze paths of teachers indicated that expert teachers tended to distribute their attention more comprehensively to a broader set of students than did novice teachers, who were prone to focus on specific students and behaviors. Kosel et al. (2020) compared the scan paths of teachers and found that the gazes of experienced teachers covered twice as many individual students than did novices.

Although these studies were conducted in western settings, they have also demonstrated experience-based distinctions across cultures. For example, McIntyre et al. (2019) conducted studies in Hong Kong and the United Kingdom to compare the proportion of eye fixation of novice and expert teachers in terms of attention (information-seeking) and communication (information-giving). The results demonstrated that the gaze of experienced teachers indicated a greater focus on students, whereas novice teachers tended to prioritize the parts of the classroom unrelated to the instruction or the activity of children. Kim et al. (2015) used eye trackers to compare novice and experienced teachers in a Korean elementary school and revealed that although novice

teachers tended to intensively focus on specific areas, expert teachers displayed a greater ability to decentralize visual attention, which was equally distributed across all meaningful aspects of teaching and learning activities.

In this regard, few studies have compared the ability of novices and experienced teachers to detect the classroom behavior of the children. Yamamoto and Imai-Matsumura (2013) found no significant difference in teaching experience between awareness and unawareness of the problematic behavior of students. However, Wolff et al. (2016) obtained a different result, whereby the attention of novice teachers was dispersed around the classroom, whereas experienced teachers were more sharply focused and tended to limit their attention to relevant visual information.

The majority of research on the visual attention of teachers has focused on learning activities and behavior in classroom settings. Among the few studies that investigated non-academic activities, Behets (1996) measured the eye fixation of experienced and student teachers, observed the slides of a gymnastics lesson, and reported their observation. Although no significant differences were noted in the number of events or the number and duration of eye fixation, experienced teachers and final-year student teachers tended to correctly report more critical events on the slide scenes than did first-year student teachers. In a rare study of the visual attention of teachers in an ECE setting, Ishibashi et al. (2020) used eye tracking to measure the number and duration of the gaze of ECEC teachers on the faces and bodies of children during snack time and indoor free play. The study found a significant negative correlation between the number of years of childcare experience and total gaze time on the child's face during snack time, although no significant differences were observed during free play. Although Ishibashi et al. (2020) elucidated the relationship between years of experience and scan paths during one activity, their study did not cover playtime supervision, which is a critical aspect of the work of nursery teachers.

In the abovementioned context, the current study aimed to contribute to the study on free play in ECEC by examining the differences between teachers with more professional experience (“experts”) and those with less experience (“novices”) in terms of their visual attention to children's free play. The findings could help ECEC providers develop strategies for helping teachers take precautionary measures in safeguarding the learning environments of children while indulging in risky forms of play.

Table 1 Summary of participants

Experience	Nursery no.	Number of children	Teacher's age (years)	Years of experience
Novice	A	15	22	1
	B	6	20	1
	C	5	20	1
	D	5	21	1
	E	8	22	1
	F	9	20	1
	G	7	22	1
	H	8	20	1
	I	10	22	1
	J	6	20	1
Novice total (average)		79	(20.90)	(1)
Relatively experienced	K	11	26	6
	L	9	26	6
	M	11	40	7
	N	12	33	10
	O	6	27	8
	P	13	25	5
	G	10	26	5
	H	8	30	10
	I	9	26	6
	J	9	29	7
Relatively experienced total (average)		98	28.80	7
All children (average)		177	(24.85)	(4)

Materials and methods

Participants

This experimental study was conducted within 1 month in the fall of 20XX.¹ The study recruited a total of 20 ECE staff, which includes novice teachers in their first-year on the job ($n = 10$) and relatively experienced teachers with 5–10 years of experience ($n = 10$), from 16 childcare centers in Japan through snowball sampling. In addition, the director of an ECE center, where I previously conducted a study, provided assistance with securing participants at other centers. All teachers were informed of the objective of the study and provided written informed consent. Table 1 summarizes the details of the teacher participants.

The appropriate research ethics committee granted the ethical approval for this study. All research was performed in accordance with the principles of the Declaration of

¹ As per ethics board requirements, the month has not been identified to protect the confidentiality of child participants.

Helsinki. All parents were informed of the objective of the study and provided written consent for their participation.

Play settings

With one exception, the sandboxes used for play were located outdoors on nursery school grounds and measured approximately 16 m². Each sandbox was surrounded by a 1-m wide boundary area. In one case, a nursery school used a sandbox at a nearby park. The sandbox measured approximately 36 m², which includes the frame outside the sandbox.

Each teacher supervised their normal class group of 3-year-old children as they played in the sandboxes at schools or in parks near their schools (two cases). The groups supervised by novice and experienced teachers averaged 7.9 and 9.8 children per school, respectively.

The study conducted 20 play sessions for a total of 60 h; thus, each teacher participated in a single 3-h session. In addition to watching the children, the teachers interacted with the children according to their usual routines. No effort was made to influence or control the interactions of the teachers with their students. Although a detailed analysis of teacher–student interactions is outside the scope of this study, verbal comments by teachers were classified into four categories, namely, question, praise, suggestion, and stop.

Visual attention of teachers

Each teacher was fitted with Tobii Pro Glasses 2, a mobile eye-tracking system. Tobii Pro Glasses 2 was first connected to a recording unit, which was then connected to a Tobii Pro glasses controller. The nursery teachers then placed the recording units in their pockets. Gaze data began when the nursery teachers entered the sandbox.

The researcher measured the scan paths of teachers in terms of fixation location, number of fixations, and overall and mean fixation duration when looking at the faces and bodies of children as they play in the sandbox, tools and sand in the sandbox, and children playing in the sandbox boundary and area immediately outside the sandbox. Gazes on a child's face covered the forehead to the jaw lengthwise and between the ears. The body was defined as any area below the child's neck, including when their backs were turned to the teacher. In the case of tools and sand, fixation was measured for each time the teacher looked at anything except for the children and other nursery teachers in the sandbox. Outside the sandbox, it is defined as the frame outside the sandbox and the immediate surrounding area.

Camera resolution was set to 1920 × 10,801 pixels, and fixation sampling frequency was set to 50 Hz. The unit of measurement for recording the time and computer time values was set to 1 ms. Visual attention or *eye fixation* was

considered identified when the scan paths of the teachers ceased for approximately 0.1 s.

Although playtimes varied across observations, the author asked each teacher to wear an eye tracker, measured their gaze, and took an arbitrary 10 min from their video data to maintain consistency. As the capture rate (the rate at which the eye tracker captures eye movement) is dependent on the weather conditions (UV) of the day, dividing those figures by the capture rate was necessary to interpret the data of each teacher as gaze frequency and duration for 10 min.

Teacher interviews

Briefly, the researchers conducted 30-min interviews with the novice ($n = 5$) and experienced ($n = 5$) teachers who agreed to participate in this portion of the study. The main questions included were as follows: “What do you pay attention to when you are with the children in the sandbox?” “When did you start paying attention to that?” and “What triggered your attention?”.

Data analysis

The study used Tobii Pro Lab Analyzer Edition v. 1.161.32145 to analyze and code the eye-tracking data. This study followed Cortina et al. (2015) and focused on eye fixation instead of other metrics, such as visits, glances, and saccades, due to the primary focus on capturing the attention of teachers and the need to reduce the complexity of data. Thus, analysis was limited to instances in which a teacher fixated on specific points in the play environment.

Descriptive statistics included fixation location, number of fixation, overall fixation duration, and mean fixation duration for each of the four participants as well as across participants. Additionally, the study performed independent sample t tests to compare the total number of fixation, overall fixation duration, and mean fixation duration of the novice and experienced teachers for each participant as well as across participants. Additionally, the study conducted independent sample t tests to compare the verbal interactions of teachers across the four aforementioned as well as overall categories. For analysis, the outer frame of the sandbox and the area outside the sandbox were combined, except when analyzing gaze sequence.

Statistical analyses were conducted via IBM SPSS version 25.

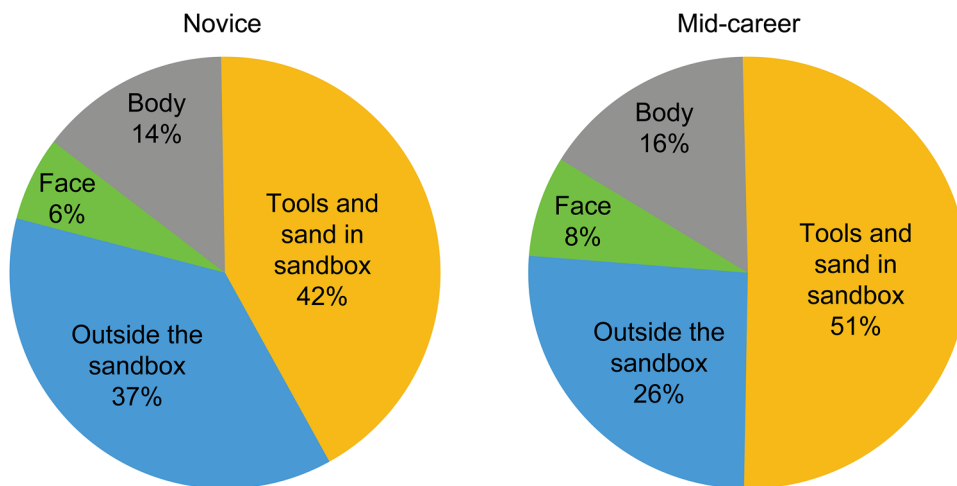
Results

Online Resources 1 and 2 in the Supplementary Information provide the details of the fixation sequences of the teachers. Regardless of level of experience, all teachers most

Table 2 Mean number of fixation per participant

	Experience	N	Mean	Standard deviation	Standard error mean
Outside sandbox	Novice	10	555.25	281.19	88.92
	Experienced	10	431.45	337.65	106.78
Children’s faces	Novice	10	94.48	82.52	26.10
	Experienced	10	125.04	98.32	31.09
Children’s bodies	Novice	10	214.68	89.75	28.38
	Experienced	10	263.25	153.66	48.59
Tools and sand	Novice	10	631.94	196.28	62.07
	Experienced	10	841.39	334.16	105.67

Fig. 1 Mean percentage of fixation per location



frequently alternated their fixation between the bodies of the children and the tools they used in the sandbox. The teachers first looked at the tools and sand followed by the outer frame of the sandbox, the bodies of the children, the area outside the sandbox, and, finally, the faces of the children. This sequence was observed 3–10 times for all participants. The average gaze capture rates for new and experienced teachers were 68% (range 30–90%) and 55% (range 18–88%), respectively. Blinking and the ultraviolet radiation emitted by the sun may have influenced these figures given that the measurements were performed during a midsummer day. When measuring eye gaze indoors using Tobii Pro, obtaining measurements approximately 100% of the time (except during blinking) is possible. However, when measuring outside, as in the case of the current study, ultraviolet rays can enter the space between the Tobii Pro glasses and eyes, which renders gaze measurements challenging.

Relationship between the work experience and visual attention of ECE teachers

Table 2 displays the means and standard deviations of the number of fixation for novice and experienced teachers per setting as well as the total values. Figure 1 provides a

Table 3 Comparison of mean fixation number across participants

Experience	Mean	SD	t (18)	p	Cohen’s d
Novice	1496.34	92.21	-4.37	0.000	1.956
Experienced	1661.12	75.43			

SD standard deviation

pictorial representation of the percentage of the time that teachers spent to fixate on each location. The teachers spent the most amount of time looking at the tools and sand followed by the outer frame of the sandbox, the area immediately outside the sandbox, and the bodies of the children. In other words, after alternately looking at the tools, the teachers most frequently observed if any children were venturing outside the sandbox, then ascertained the children at play. Although relatively experienced teachers looked more frequently than did novice teachers at the bodies and faces of the children, tools, and sand and less frequently looked outside the sandbox, the independent sample t tests found no significant difference in the number of gazes of these individual participants.

Table 4 Mean fixation duration: all gazes

	Experience	N	Mean (ms)	Standard deviation	Standard error mean
Outside sandbox	Novice	10	148.08	79.99	25.30
	Experienced	10	92.65	71.05	22.47
Children's faces	Novice	10	33.34	33.59	10.62
	Experienced	10	30.05	24.10	7.62
Children's bodies	Novice	10	52.43	22.75	7.19
	Experienced	10	57.25	42.37	13.40
Tools and sand	Novice	10	186.05	68.06	21.52
	Experienced	10	210.93	94.04	29.74

Variation in visual attention of expert and novice ECEC teachers

Table 4 presents the total duration of the fixation of the teachers for each location. Once again, although experienced teachers gazed longer overall at the bodies of the children and the tools and sand than did novice teachers and spent less time looking at the faces of the children and outside the sandbox, the independent sample *t* test reported no significant differences between groups, individuals, or across participants. Figure 2 depicts the comparison according to the percentages.

Figure 3 displays the mean fixation duration, which

Fig. 2 Mean percentage of fixation duration per location

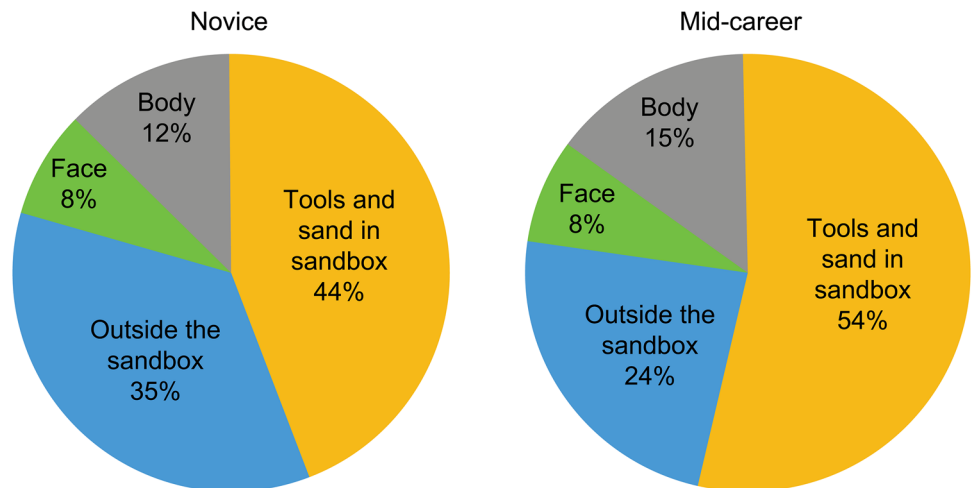
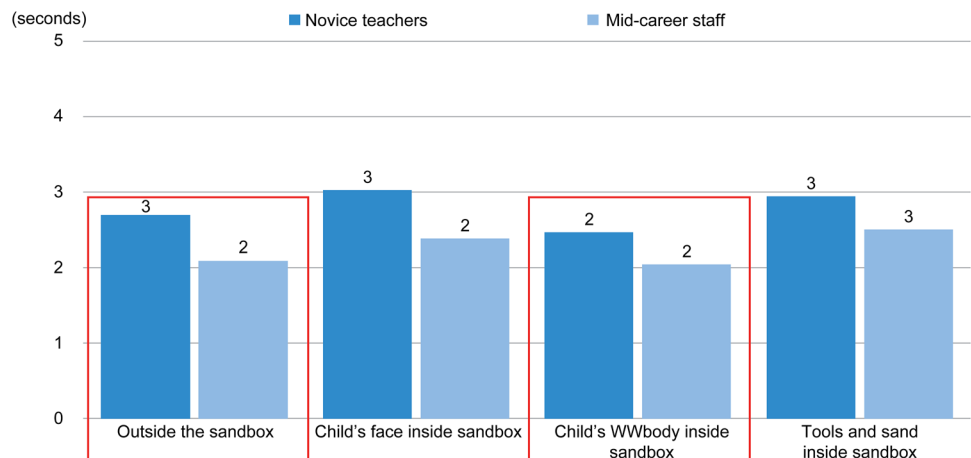


Fig. 3 Mean fixation duration for each participant



However, as Table 3 reveals, an independent *t* test that compares the mean number of total fixation across participants combined demonstrated that experienced teachers exhibited significantly more number of fixation than did novice teachers with a large effect size.

reveals that the gazes of relatively experienced teachers were consistently shorter than those of novice teachers. As Table 5 indicates, an independent sample *t* test led to significant differences between novice and experienced teachers in terms of mean fixation duration across all

Table 5 Comparison of mean fixation duration between novice and experienced teachers

	Experience	Mean (s)	SD	<i>t</i> (18)	<i>p</i>	Cohen's <i>d</i>
Outside sandbox	Novice	0.27	0.05	2.94	0.009	1.31
	Experienced	0.21	0.04			
Children's faces	Novice	0.30	0.11	1.62	0.124	0.77
	Experienced	0.24	0.05			
Children's bodies	Novice	0.25	0.05	2.19	0.042	0.98
	Experienced	0.20	0.03			
Tools and sand	Novice	0.29	0.05	1.83	0.083	0.82
	Experienced	0.25	0.06			
Across participants	Novice	0.28	0.05	2.86	0.010	1.29
	Experienced	0.22	0.03			

SD standard deviation

Table 6 Mean fixation duration when looking at children versus areas without children

	Experience	Mean (ms)	SD	<i>t</i> (18)	<i>p</i>	Cohen's <i>d</i>
Children	Novice	0.55	0.15	2.05	0.055	0.92
	Experienced	0.44	0.06			
No children	Novice	0.56	0.08	2.78	0.012	1.25
	Experienced	0.46	0.09			

SD standard deviation

participants, as well as when looking outside the sandbox and at the bodies of the children as they played in the sandbox. For all cases, Cohen's *d* values indicated a large effect size. In other words, experienced teachers were better at assessing children at play and determining whether or not they ventured outside the sandbox.

Table 6 presents the results of the independent sample *t* test that was intended to compare the mean fixation duration, where novice and experienced teachers looked directly at children as well as at spaces that did not contain children. The results revealed that experienced teachers spent significantly less time looking at spaces that do not involve children than did novice teachers with a large effect size. A comparison indicated that the mean gaze duration of experienced teachers was also substantially shorter than that of novice teachers when looking directly at the children, although the difference did not reach a statistically significant level.

During the brief interviews, the novice teachers mentioned challenges in dividing their time between facilitating play with individual children and watching the entire group. As one teacher explained,

I spend a lot of time looking at the child in front of me because I cannot see everything. When I see 3-year-old children playing with each other, I encourage them. However, I regret focusing on the children in front of me because other children are fighting with each other in places that I do not notice.

Table 7 Verbal interactions between teachers and children

	Novice	Experienced
Question	39.9 (9.63)	32.2 (11.71)
Praise	3.80 (3.36)	4.60 (3.66)
Suggestion	0.9 (1.45)	.5 (.71)
Stop	10.3 (11.39)	8.5 (8.57)
Total	54.9 (3.90)	45.8 (12.31)

In contrast, experienced teachers noted that they acquired greater skills in focusing on the entire group instead of on individual children. One teacher noted that "I look at children more often than I used to do. I am aware that I can make decisions faster than in the past." Similarly, another teacher explained:

I used to observe each child individually to know what they were doing. Now, I look at everyone to get the whole picture. I look at children's play and anticipate what they are going to do.

Verbal interactions of teachers

Table 7 presents the means and standard deviations of the commentaries of the teachers during children's play. Notably, both groups asked the children questions more frequently than they did any other type of comment. The

questions tended to be related to the actions and intentions of children such as “What are you doing?,” “What are you going to do with that?,” and “What do you want to do?”.

Although fewer comments were noted for experienced teachers than that of novice teachers for each category except for “praise,” the difference was non-statistically significant. However, the experienced teachers engaged in significantly less commentary with children than did novice teachers ($t(18) = 2.23, p = 0.039$).

The findings from the brief interviews indicated that novice nursery teachers tended to engage in verbal interactions with the children due to safety concerns and uncertainty regarding the activities of the children. As one novice teacher explained:

I talk with children a lot because I do not understand them well [...] If the children’s clothes get dirty with sand, I am always careful not to forget to tell the parents about it. I also try to ensure that the children do not get hurt.

Novice teachers also more commonly referenced speaking with children about their activities:

I felt that I had to see the whole, but I also wanted to be involved with the children. I ask the children what they are doing and play with them. I also take care to keep them out of trouble and provide them with the tools that they need.

In contrast, the experienced nursery teachers emphasized the importance of talking with the children less, such that they could think for themselves and cooperate with their friends. As one experienced teacher described,

I make sure that children have the tools they need and that there is enough space for their friends not to bump into each other. I take care to create an environment in which children can immerse themselves in play.

Similarly, another teacher explained:

As much as possible, I try not to say what I think. Children must think of themselves and play cooperatively with their friends. If caregivers give advice first, then children’s creativity will decline and they will not play at their own will. In the past, I used to tell children, “If you do that, the sand pile will collapse, so don’t do it,” or “Your clothes will get dirty, so do not do it,” but now I am careful not to tell them those things.

The experienced teachers mentioned anticipating what the children were going to do and making decisions by listening to the conversations of the children among themselves. One teacher noted that “I listen carefully to the children’s conversations and let them realize their ideas and express themselves with sand.” Other experienced teachers described

balancing safety concerns and the need to nurture independent play among children.

I do not dictate conversations with the children. I try to talk to the children according to their circumstances. I try not to talk to the children more than necessary because once the nursery teacher suggests how to play, the children will not develop their play naturally. I also ensure that children do not eat sand or that sand does not enter the children’s eyes.

I do not talk to the children when they are concentrating on each other.

When I play with children, I listen to their conversations. I also tell them to feel the sand. I am aware of what needs to be nurtured during my play. These may be relationships, physical exercise, or contact with nature.

Discussion

This study compared the total number and duration of fixation as well as the mean fixation duration of new and relatively experienced ECE teachers as they watched children play in and near sandboxes. The results indicated that the experienced teachers gazed at the children more frequently than did novice teachers; however, the mean fixation duration was significantly shorter among the former across subjects. Similarly, although the experienced teachers spent more time overall than did novice teachers on observing the children and the peripheral areas of the play area, the mean fixation duration was significantly shorter than that of the novice teachers.

Relationship between the work experience and visual attention of ECE teachers

RQ1 pertains to the influence of the level of experience on the number of fixation, fixation duration, and mean fixation duration of ECE teachers when supervising children at play. The results indicated that experienced teachers recorded significantly more numbers of fixation than those of novice teachers, although no significant difference was noted in the total fixation duration. However, the mean fixation duration of the novice teachers was consistently shorter than those of the experienced teachers.

The results are in line with the findings of Ishibashi et al. (2020), who confirmed that experienced ECEC staff evinced more fixation than novice teachers during snack time. The findings also partially agree with the negative correlation demonstrated by these authors among the years of experience of ECEC staff and number of fixation and time spent gazing at the faces of children, although the difference

between novice and experienced teachers was non-significant in the current study. Although Ishibashi et al. (2020) did not find a significant difference between teacher gaze during free play based on years of experience, their study notably distinguished between teachers with less than and more than 7 years of experience. In contrast, the current study drew a starker contrast between truly novice ECE teachers who had been working in the field for one year or less and those working for at least 5 years. Moreover, Ishibashi conducted the study in indoor settings, which are characterized by lesser safety concerns compared with outdoor settings, in which teachers must expend more effort to ensure that children do not wander away from the play area.

Similar to the current study, Huang et al. (2021) found that expert teachers exhibited a greater number of fixation and an overall shorter gaze duration than those of novice teachers. Although McIntyre et al. (2017) found that expert teachers looked longer at students than did novice teachers in classroom settings, the former also demonstrated greater gaze efficiency.

Variation in visual attention of expert and novice ECE teachers

RQ2 is related to variations in fixation between novice and experienced teachers while looking at the faces and bodies of the children and areas adjacent to the play area during playtime. The difference between the novice and experienced teachers reached a level of statistical significance, when the teachers observed the bodies of the children as they played in the sandboxes and looked at the area immediately outside the sandbox. Similarly, a comparison of the mean duration of fixation on the children directly and in nearby spaces proved that the fixation of the experienced teachers is briefer than that of novice teachers for both cases and significantly less in the latter case. In other words, the experienced teachers gazed more frequently at the children and could assess their activities and behavior more quickly.

In classroom settings, Carter et al. (1988) found that expert teachers frequently exhibited a significantly enhanced ability to perceive and interpret the activities and behaviors of children than did novice teachers, which includes the ability to better weigh the comparative importance of different pieces of visual information and form connections them. Similarly, Jarodzka et al. (2010) found that expert teachers evinced greater attentional skills, which enabled them to focus more on pertinent instead of irrelevant visual information. In the play setting, this finding may indicate that experienced teachers feel less compelled to supervise and intervene in the activities of children; however, this interpretation should be confirmed with additional and detailed qualitative data that capture the perceptions of teachers about children's play. Notably, a classroom study by Kosel et al. (2020) did

not focus on the length of gazes; however, they found that the scan paths of expert teachers were characterized by more frequently recurring glances at students compared with those of novice teachers, where the visual strategy of the former entailed regular check-ups on the targeted students.

In the current study, the significantly large number of fixation of the experienced teachers along with the lower fixation duration among this group suggests that they were able to quickly discern the nature of the movements of the children through a few glances and within a short time. In contrast, the novice teachers spent more time observing each participant, which indicated that they needed more time to assess events. This interpretation is supported by the interview data, which indicated that the novice teachers faced challenges in balancing their attention between individual children and the group, whereas experienced teachers exhibited the ability to "see the whole picture" and make decisions more quickly than they did in the past.

Other comparisons between new and experienced teachers in classroom settings seemingly contradict the conclusions of the current study. For example, the experienced teachers exhibited more gazes while looking at the children, but their mean gaze duration was shorter than those of the novice teachers. This observation differs from the study conducted by Moreno et al. (2002), which indicated that more experienced teachers displayed longer but less fixation on relevant areas in the classroom. Similarly, McIntyre et al. (2017) found that expert teachers displayed a longer gaze duration than did novice teachers when looking at their students. However, in contrast to the abovementioned classroom studies, which were conducted in settings that involved structured activities, the current study focused on unstructured free play for students. In this context, whether or not the gazes of the experienced ECE teachers were shorter because they found play less relevant than other activities or because they understood that an excessive focus on children's play could constrain the children from achieving the full benefits of their activities remains unclear.

Scan path data

This study found that regardless of level of experience, all teachers most frequently alternated their fixation between the bodies of the children and the tools they used in the sandbox. The teachers first looked at the tools and sand followed by the outer frame of the sandbox, the bodies of the children, the area outside the sandbox, and the faces of the children.

Practical implications

The results can be considered in the context of qualitative studies, in which ECEC teachers expressed the importance

of experience and knowledge when supervising free time for children (Bubikova-Moan et al., 2019; McInnes et al., 2011; Sadamatsu, 2021). Novice teachers are typically concerned about their ability to manage risk during children's free play, whereas experienced teachers tend to be more acquainted with the playing styles of children and can quickly differentiate between excessively risky and safe play behaviors (Bubikova-Moan et al., 2019).

This study is important to the field of childcare research and for nursery teachers and children, because it reports that the ability of nursery teachers to manage risks is dependent not only on their knowledge and experience but also on the speed of their physical line of sight. The study supports the notion that the experience and intuition of nursery teachers strongly influence the quality of childcare; however, this notion alone is insufficient for ensuring the appropriate management of risk in this setting. The eye-tracking data revealed the physical speed and location of the eye gaze, which could contribute to a better understanding of future childcare practices. Additionally, this study on experienced nursery teachers advanced the current understanding of the expertise of teachers in childcare practices, which leads to more rapid judgments of the behavior of children.

Limitations and future research

This study has several limitations. First, the scope was limited to tracking the frequency and duration of the fixation of teachers instead of the quality and context of the fixation. Thus, future research should attempt to classify the behaviors of teachers and evaluate their relationships with gaze behaviors. Additionally, this study did not record the behavior of the children, teacher–child interactions, or the nature of such encounters. Therefore, it was not possible to exploring the relationship of the teachers' gaze behaviors, scan paths, and interactions with children with the behavior of the children. Numerous studies found that teacher–child interactions during play can exert positive impacts on the development of children when such interactions are collaborative instead of interfering. In this regard, future studies should strike a balance between eye-tracking measurements and additional observations of child–teacher interactions during play. Additionally, the study included only brief interviews with teachers to discern their attitudes toward children's play. Future research could combine eye-tracking measurements with lengthier interviews to confirm the factors that influence the differences in gaze behaviors between novice and experienced teachers.

The findings indicate that the experienced ECE teachers may intend to avoid lengthy gazes at children as they play, which, thus, reduces the appearance of intense supervision that could hinder children's play. Notably, the study found that the more experienced teachers engaged in significantly

less total verbal interaction with the children, which could suggest that they were willing to allow children to play with less guidance. Additionally, the interview data indicated that the experienced teachers were more apt to take cues from the conversations of children instead of engaging them directly. Moreover, they expressed more concern about simply creating an immersive environment and not interfering with children's play. However, this line of interpretation remains speculative pending future research, because this study did not collect data regarding the behavior of children.

Conclusion

The findings support the notion that experienced teachers exhibit a heightened ability to assess conditions more quickly and draw conclusions regarding the activities of children. Moreover, the results support research that indicates that the level of supervision and control imposed by ECE teachers on children's play and safety are closely related to their level of experience.

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Data availability The data that support the findings of this study are available upon request from the corresponding author. The data were not publicly available because they contained information that could compromise the privacy of the research participants.

Declarations

Conflict of interest The author has no relevant financial or nonfinancial interests to disclose.

Ethical approval Ethical approval for this study was granted by the Research Ethics Committee of the Osaka University of Comprehensive Children Education (approval number: JI-HO-KEN-052). All research in this study was performed in accordance with the principles of the Declaration of Helsinki.

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