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Professional Learning on the Neuroscience of Challenging Behavior: Effects on Early Childhood Educators' Beliefs and Practices

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Introduction

Emotionally supportive relationships between children and their educators are a key factor in quality early learning environments (McNally & Slutsky, 2018) and are critical to children's long term academic and developmental success (Magnuson et al., 2004; Yazejian et al., 2015). Emotionally supportive student–teacher relationships in the early years increase the likelihood that a child will experience success at school (McCormick et al., 2013; Sabol & Pianta, 2012). Research examining the etiology of student–teacher relationships has shown that challenging behavior may strain the student–teacher relationship (Jeon et al., 2019; Mantzicopoulos, 2005). Unfortunately, the incidence of challenging behavior in early education is rising, as evidenced by educator survey data (Offord Centre for Child Studies, 2017) and rising preschool expulsion rates (Gilliam et al., 2016), putting many children at risk for conflictual teacher relationships and the developmental and academic difficulties that follow. This data brings to light the urgent need to support educators in regard to challenging behavior as a primary means to improving student–teacher relationships.

Professional learning interventions designed to improve student–teacher relationships in early childhood education have not focused on the central role of child behavior but rather, have aimed to increase educator responsiveness via programs designed to directly change their interactions with children (Sabol & Pianta, 2012). Although it is important to directly address teachers' interactions with children, recent neuroscience findings that explain behavior as the result of the nervous system's adaptive response to stressors, has the potential to change how educators understand challenging behavior and to thereby shift their beliefs and practices. Specifically, the neuroscience invites educators to reframe perceived misbehavior as stress behavior, encouraging a more compassionate response to the child. Training early educators to understand child behavior using a neuroscientific lens, has not, to our knowledge, been explored as a means to promoting educator emotional support. This study aimed to investigate whether a professional learning intervention with early childhood educators on the neurophysiology of child behavior could impact their ability to be emotionally responsive. To achieve the goals of the study, educator beliefs and practices regarding challenging behavior were examined.

Literature Review

Educator Responsiveness and Child Outcomes

Research showing a clear connection between educator responsiveness, and consequent positive student–teacher relationships, points to the importance of finding ways to increase educator capacity to be emotionally supportive. Studies investigating the significance of early educator emotional support have shown a relationship between educator responsiveness and a variety of academic, socio-emotional, and behavioral outcomes for children. Positive associations between the quality of children's relationships with their educators and their academic achievement in a variety of school subjects has been reported (Crosnoe et al., 2010; McCormick et al., 2013). First-grade children at risk for school failure have been shown to obtain achievement scores commensurate with their low-risk peers when placed in classrooms with emotionally supportive teachers (Hamre

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& Pianta, 2005) and longitudinal studies have shown that an emotionally responsive educator in preschool is linked to stronger vocabulary and decoding skills at the end of first grade (Connor et al., 2005). Moreover, teaching that is sensitive to a child's needs in the primary grades has been shown to mediate the negative impact of a difficult child temperament on achievement (Valiente, et al., 2008).

Beyond academic achievement, emotionally responsive educators have also been associated with a child's emotional development and prosocial behavior in the classroom (Griggs et al., 2016). Specifically, teacher emotional support has been related to reduced child aggression, increased behavioral control (Merritt et al., 2012), and less disruptive peer play (Griggs et al., 2009). Additionally, first-grade children in classrooms where teachers are rated as emotionally supportive show better stress regulation capacity than their peers in unsupportive classrooms (Ahnert et al., 2012) and conversely, high conflict teacher–child relationships have been associated with decreased self-regulation skills and social competence in children (Portilla et al., 2014).

Challenging Behavior and Educator Responsiveness

It is clear that emotionally responsive educators are important to child success in early education classrooms; however, research shows that educator responsiveness is significantly impacted by challenging behavior. Specifically, children who demonstrate aggressive or externalizing behaviors are more likely to have relationships with teachers that are rated high in conflict (Mejia & Hoglund, 2016; Sabol & Pianta, 2012) and teachers' interactions with children who they rate as having behavior problems are more verbally demanding in nature (Dobbs & Arnold, 2009). Indeed, longitudinal research shows a bi-directional and lasting association between child externalizing behavior and student–teacher conflictual relationships from preschool to third grade (Skalická et al., 2015).

Further research in this area suggests that it is the teacher's perception, or attribution, of child behavior that is implicated in the nature of their response. Specifically, when educators attribute challenging behavior to "controllable" factors (i.e., being within the control of the child), it provokes negative emotions and punitive responses (Dagnan et al., 1998) and negative beliefs about behavior have been shown to lead to educators responding in reactive ways, such as using time-out, restraint, and removal of privileges (Nungesser & Watkins, 2005).

This research suggests that one avenue by which to improve educator responsiveness to children might be to increase their understanding of the nature of challenging child behavior, and particularly, its automatic, neurophysiological roots.

Child Behavior as a Neurophysiological Phenomenon

While child behavior is understood to be a primary variable in the quality of early student–teacher relationships and an educator's capacity to be emotionally responsive, child behavior itself, and specifically, its automatic neurophysiological roots, is not widely understood by early years educators who may see behavior as an entirely controllable phenomenon (Blair & Raver, 2015). Research by Nash et al. (2015) shows that 86% of primary educators believe that children are in control of their behavior and choose to be disruptive. Further, Teyfur's (2015) finding that 26% of primary educators manage undesirable behavior by 'not showing love' (p. 2429) illustrates how a belief that challenging behavior is a choice might translate to punitive practice.

This view of maladaptive behavior as within the control of the child, is now being challenged by recent scientific findings which reveal that the limbic, or emotional center, of the brain drives executive function and self-control capacities, and that this limbic region is in turn, driven by one's neurophysiological response to stress, or stress response system (Gunnar & Hostinar, 2015; Gunnar & Quevedo, 2007; Thompson, 2014). Excessive stress activates the stress response and prioritizes neurophysiological functions designated for survival (such as dilating pupils, and increasing heart rate and blood flow to the muscles) simultaneously impairing the executive function and self-regulation capacities of the prefrontal cortex (Blair et al., 2005).

Through a neurophysiological lens, challenging behavior may be understood as a consequence of an overtaxed stress response system. In this view, challenging behavior may not be a choice that the child makes, but rather the consequence of excessive stress. Understanding the individual stressors of a child, might enable the educator to mitigate the stress before it become excessive and leads to maladaptive behavior where further intervention is needed. This reframing of misbehavior as stress behavior, encourages educators to assist the child in reducing the stress that may be impinging on his or her nervous system and to help the child to develop adaptive mechanism for self-regulation, rather than discipline the behavior in a frustrated fashion or try to rationalize with the child, both responses that can serve to exacerbate the defensive behavior of the child whose ability to reason is reduced when their stress response system is engaged (Diamond & Lee, 2011). One theoretical framework that explains child behavior as a neurophysiological construct associated with stress, is Shanker's (2016) Self-Reg theory. Developed with educators in mind, this theory explains child

behavior as the downstream result of the brain's response to internal and external stressors. A fundamental tenet of Self-Reg theory invites educators to ask Why? and Why now? and to search for the stressors when a child displays challenging behavior.

Present Study

Relationships between educators and children are significant to child success yet they are threatened by challenging behavior. Many researchers have highlighted the need for professional learning specific to children's challenging behavior (Buettner et al., 2016; Partee et al., 2020). Additionally, there have been calls to integrate neuroscience into early education practices (Ansari et al., 2011; Blair & Raver, 2015). The present study aims to address these gaps by examining the potential of an in-service professional learning program on the neuroscience of child behavior to shift educator beliefs and practices in regard to challenging behavior toward a more emotionally supportive stance. The primary research question is: Does participation in a professional learning course on the neuroscience of child behavior change early educator reported beliefs and practices in regard to the challenging behavior of children in comparison to controls? A supplemental question asks: What are educators' perspectives on the neuroscientific content and format of the professional learning experience?

Methods

In order to answer the question related to the impact of a professional learning course on educator beliefs and practices regarding challenging behavior, a mixed methods design was employed. Consistent with the convergent parallel design, quantitative pre- and post-survey data and qualitative post intervention site visit and focus group data, were collected and analyzed separately and then considered together to find potential points of convergence or divergence (Creswell, 2012). In this study, qualitative data was utilized in a supplemental fashion to provide a more comprehensive understanding of the impact of the professional learning than would be gained via quantitative data alone (Creswell & Plano Clark, 2007).

Participants

There were 200 early childhood educators, working within a large cooperating child services organization in a suburban area of Canada, who were invited to complete an Educator Survey on their classroom experiences and practices with regard to child behavior. Included in the Educator Survey was a question that asked respondents to indicate their interest in participating in a professional learning course pertaining to the survey's topics. This question allowed for the recruitment of a subsample of educators for the professional learning intervention. A total of 42 survey respondents, 41 female and one male, indicated an interest in the professional learning opportunity. Early educators ranged in years of work experience from 5 to 20 + years and reported working with children from infant to kindergarten age at the time of the study. These 42 practicing early childhood educators were randomly assigned to either a professional learning (PL) (n = 20) or control (n = 22) group. All 42 participants provided pre and post survey data (5 months later) on their beliefs and practices regarding child behavior, and the PL participants also participated in site visits and focus groups following the intervention. Control participants were invited to attend a session of the professional learning following the completion of data collection for the study.

Procedures

Pre-Intervention

A survey was distributed that was designed to measure educator beliefs and practices in regard to child behavior, and specifically the extent to which beliefs and practices reflect an understanding of child behavior as related to automatic neurophysiological systems as opposed to being a willful act was distributed. Given the lack of a published tool to measure this specific neuroscientific aspect of early educator beliefs and practices, two subscales were devised based on the research literature (e.g., Blair & Raver, 2015; Diamond & Lee, 2011; Irish National Teachers' Organization, 2004) and then piloted with 100 in-service early childhood educators. The pilot had two purposes: first, to identify areas where clarification in either instructions or items were needed, and, second, to assess the reliability of the Beliefs Regarding Child Behavior and Practices Regarding Child Behavior scales. Based on pilot respondent feedback, minor changes were made to item wording. Internal consistency of the 15-item Educator Beliefs Regarding Child Behavior scale and the 15-item Educator Practices Regarding Child Behavior scale was analysed using Cronbach's Alpha and was found to be 0.77 and 0.75 respectively. These are considered acceptable reliability coefficients (Adams & Lawrence, 2015). Following this pilot, the revised survey was then administered to the full cohort of 200 ECE participants, from which PL and control group participants were derived as described above.

Intervention

The intervention in this study consisted of a two-day professional learning course on the neurophysiology of child

behavior, as framed by Self-Reg theory (Shanker, 2016), and a follow-up site visit to the 20 intervention participants. Various theoretical sources on the neurophysiology of behavior were used to develop the two-day professional learning course, and videos and graphics were incorporated to illustrate theoretical information. Participants were provided with paper copies of course materials. The professional learning was delivered by the first author, a community speaker on Self-Reg theory and professor of child development. The following were the broad topics for each day of training: (Day 1) *The Brain, Stress, and Self-Regulation: The Roots of Behavior,* and (Day 2) *Self-Reg in Practice: Reframing Child Behavior.* Topics for Day 1 included the brain and the neurophysiology of stress, the nature of self-regulation, and sources of stress. Topics for Day 2 included distinguishing self-regulation from self-control, distinguishing stress behavior from misbehavior, and the role of emotional support in alleviating stress. Considerable attention was given to what is known about effective professional development for early years educators. For example, case studies and videos were used to go beyond simple 'information giving' to include demonstrations, practice, and feedback from the facilitator (Sheridan et al., 2009). All participants attended both days of the professional learning.

Four weeks following the intervention, one 30-min follow-up visit to each of the 20 PL participants' workplaces was scheduled. Site visits served the dual purpose of providing an opportunity for participants to ask questions regarding the application of professional learning content to their practice, while allowing the researcher to make note of participant comments in regard to the professional learning. These visits were conducted using a conversational style approach (Patton, 2015) and as such were informal meetings. The first author began the conversation with a standard prompt in regard to whether she could answer any questions in regard to the content of professional learning, now that the participant had had the opportunity to apply it to their practice. Consistent with the conversational style approach, these visits were unstructured aside from this introductory prompt. The researcher took notes on participant comments.

Post-intervention

All PL and control group participants retook the Educator Survey three months following the professional learning intervention. Following this, the PL participants were invited to attend one of two 90-min focus group interviews in order to gather a deeper level of educator thoughts, feelings, and impressions regarding the impact of the professional learning than would have been possible through survey data and site visits alone. The two focus groups, with seven and eleven participants respectively, were 60 and 90 min long. The primary question participants were invited to respond to was: "Did the professional learning influence your beliefs or practices in regard to challenging behavior following the professional learning? If so, how?" Focus groups were recorded and later transcribed by a third party. Participants were assigned a number and were referred to by number in order to preserve anonymity (see Table 1 for an overview of study design).

Materials

Survey

Background Information This section of the survey includes nine items in total that gather relevant background information on participants such as gender, years of work experience, and experience with children exhibiting challenging behavior.

Section 1: Beliefs Regarding Child Behavior This section of the survey contains 15 items designed to collect data on educator beliefs regarding the nature of child behavior (see Online Appendix). Items within this section measure the degree to which educators report believing behavior is a consequence of a child's capacity for self-control (items 1, 3, 5, 6, 8, 10, 11, 12) versus their neurophysiology (2, 4, 7, 9, 13 14, 15) (Blair & Raver, 2015; Diamond & Lee, 2011;

Table 1 Study design overview

Pilot phase	Pre-intervention phase	Intervention	Post-intervention phase	Post-study phase
Survey piloted *n* = *100*	Survey Administered *n* = *200*	*Intervention Group*	*Intervention Group*	
		2-day PL delivered	Survey re-administered	
		Post-PL Site Visits conducted	Focus Groups conducted	
		n = *20*	*n* = *20*	
		Control Group	*Control Group*	*Control Group*
		No PL	Survey re-administered	Courtesy PL delivered
		n = *22*	*n* = *22*	*n* = *22*

Shanker, 2016). Educators were asked to indicate their level of agreement with each item on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree." Items 2, 4, 7, 9, 13, 14, and 15, which represent a view of behavior as a neurophysiological phenomenon, were reverse scored. For example, item 1 reads: "I believe that children are generally in control of their behavior" and item 7, a reverse scored item states: "I believe that behavior can be a consequence of brain and body systems that operate beyond a child's control." Higher scores on this measure represent a stronger belief that children are in control of their behavior and therefore choosing to misbehave. Internal consistency of this 15-item scale was calculated using Cronbach's Alpha and was found to be 0.79.

Section 2: Practices Regarding Child Behavior This section of the survey also contains 15 items designed to collect data on educator practices regarding child behavior (see Online Appendix). Items in this section measure the degree to which educators report engaging in a thoughtful, emotionally supportive, and individualized way versus a more reflexive, discipline based, and standardized fashion when responding to children's challenging behavior. Items 1, 4, 7 and 10 reflect the methodologies of intervention studies aimed at improving the emotional support provided by educators (e.g., Hamre & Pianta, 2005). Items 6 and 15 are adapted from Arnett's Caregiver Interaction Scale (1989), which is designed to measure emotional tone, disciplinary style, and the responsiveness of the educator. Items 3, 5, 8, and 12 reflect Shanker's (2016) claims that a key component of responsive educator practices regarding child behavior involves the educator pausing to ask themselves why this behavior might have occurred before responding. Finally, items 2, 9, 11, 13 and 14 reflect a report published by the Irish National Teachers Organization (2004) that outlines strategies for teachers on how to respond to challenging behavior. Scoring was based on a 5-point Likert scale ranging from "never" to "always." The following are sample items for this section: "My discipline practices involve isolating children who are displaying challenging behavior" (Item 2); and Item 4, a reverse scored item, reads: "When a child is displaying challenging behavior, I offer emotional support." Higher scores on this measure indicate more standardized, discipline-based practices in response to challenging behavior. Cronbach's Alpha for this scale was found to be 0.70.

Data Analysis

In order to examine the impact of the two-day professional learning on educator beliefs and practices regarding child behavior, both pre- and post-intervention survey data and qualitative data collected from the site visits and focus groups with PL participants were examined. Consistent with the convergent, mixed-method approach, quantitative and qualitative data were analysed separately and then considered together to find potential points of convergence or divergence (Creswell & Plano Clark, 2007).

To assess the significance of the differences in means between the PL and control groups, pre- and post-intervention on beliefs and practices variables, a repeated measures ANOVA with one between subject factor (i.e., group) and one repeated-measures factor (i.e., time) was conducted for each of the dependent variables. This analysis assesses differences between groups pre-intervention (i.e., time 1), between groups post-intervention (i.e., time 2), and differences pre and post-intervention for each group in one analysis. This mixed ANOVA also tests the interaction of the two factors (i.e., group and time) on the dependent variable of interest which, if significant, can be further analysed with a post-hoc test. Running this omnibus test over multiple subtests avoids the error associated with getting statistically significant results by chance alone.

The qualitative data from the site visits and focus groups provided additional insight into the impact of the professional learning. Examination of qualitative data began with transcriptions of the two focus group sessions in their entirety. Focus group data were then systematically coded using the in-vivo coding method (Miles et al., 2014). In-vivo codes were then categorized using Merriam and Tisdell's (2016) rules for category construction; categories were exhaustive, mutually exclusive, sensitive to the data, and conceptually congruent. Site visit notes were then analysed using the deduced categories in constant-comparative style (Strauss & Corbin, 1998). A new category regarding the effectiveness of professional learning emerged from the site visit data, and focus group data were then re-scanned for any evidence of this new category. From this master list of categories, a list of general themes was developed. These themes were then member-checked with the PL participants. Ten of the 20 participants responded to this member-checking request, all of whom indicated agreement with the proposed themes with no further comment. The final five themes are discussed below.

Results

Reported Beliefs and Practices About Child Behavior: Survey Data

This research examined whether or not participation in professional learning on the neurophysiology of behavior changes early childhood educator reported beliefs and practices regarding children's challenging behavior. Table 2 provides an overview of the pre and post intervention means

Table 2 Pre-post means and standard deviations for PL and control groups on beliefs and practices scores

Variable	PL				Control			
	Pre		Post		Pre		Post	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Beliefs	36.65	8.91	28.20	6.36	36.95	5.86	35.80	5.38
Practices	37.20	5.75	30.50	4.82	35.90	6.39	34.10	5.95

for each of the PL and control groups on the beliefs and practices variables.

Results from the series of ANOVA's using beliefs and practices scores as the dependent variables show that both the beliefs regarding child behavior and practices regarding child behavior scores were significantly impacted by the two-day professional learning. The ANOVA results show a significant interaction between time and group in terms of belief scores, $F(1, 39) = 15.72$, $p < 0.001$, $d = 1.29$, and also a significant interaction between time and group in terms of practices scores, $F(1, 39) = 12.54$, $p < 0.001$, $d = 0.66$. Post hoc pairwise comparisons of these interaction effects indicated that the post intervention mean score on the beliefs variable for the PL group ($M = 28.15$, $SD = 6.36$) was significantly different from the control group ($M = 35.81$, $SD = 5.38$). Pairwise comparisons also show that that the PL group's posttest scores on this measure significantly differ from their own pretest scores ($M = 36.\ 65$, $SD = 8.92$). Likewise, post hoc pairwise comparisons for the practices variables show that the PL group's mean score on the practice measure ($M = 30.45$, $SD = 4.83$) was both different from the control group posttest ($M = 34.19$, $SD = 5.95$) and also significantly different from its own pretest scores ($M = 37.2$, $SD = 5.75$). Plots of means of these variables shown in Figs. 1 and 2 depict the difference between the groups over pre and posttest times.

Themes

The following five themes emerged from the site visits and focus group data: Theme 1: Belief changes regarding child behavior; Theme 2: Practice changes regarding child behavior; Theme 3: Recognition of brain processes and the neurophysiology of stress; Theme 4: Reflection on stress of self and others; and Theme 5: Positive and effective professional learning experience. Themes 1 and 2 directly support quantitative findings in regard to changed beliefs and practices regarding challenging behavior.

In regard to Theme 1, there was an overall sense that beliefs about child behavior shifted from a fixed, character-based and accusatory stance to a more open and inquisitive stance (i.e., asking why, wondering). During site visits and

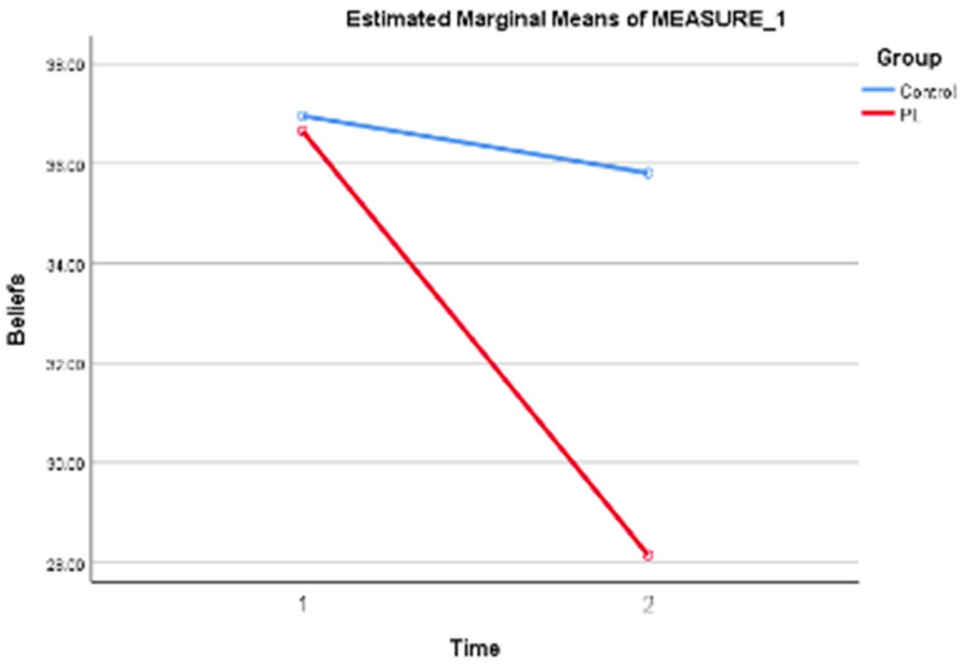

Fig. 1 Effects of group and time on beliefs scores

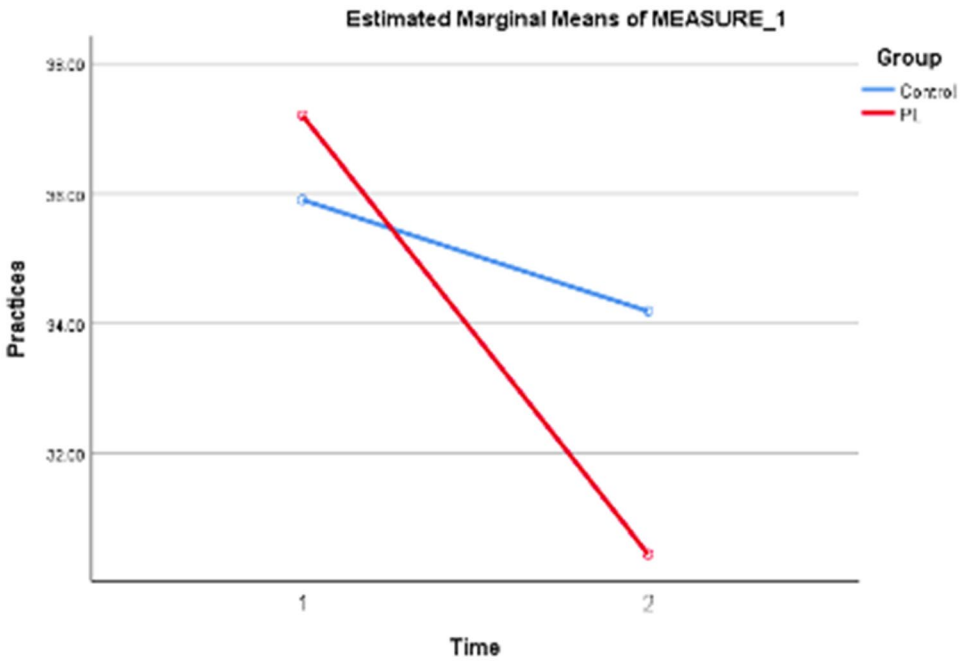

Fig. 2 Effects of group and time on practices scores

focus groups, many educators spoke about how before the professional learning they believed children were "being bad" or "seeking attention" when they "misbehaved". Comments such as "I see now that kids don't always misbehave on purpose" (Jane) and "I see now how this child is not attached to his behavior" (Tracy) reflect the idea that challenging behavior is not indicative of a "bad" child. This shift in beliefs was exemplified by Isabelle who noted, "After 34 years, [the training] has opened my eyes to seeing children through a different lens", she continued, "I see a child who is having a difficult day, not a difficult child."

Qualitative data concerning practices in regard to child behavior (Theme 2) mirror the changes in beliefs discussed above, shifting from a standardized, disciplinary approach to an inquisitive, individualized approach. For example, Anna commented that "Before my thoughts would go straight to 'how do I make this stop' but now I really dig deep into figuring out what the stressors are, so I'm more observant, more responsive, less reactive." Hana elaborated on this idea by suggesting she has become more curious in response to challenging behavior saying, "Before if a child was misbehaving, I would just take that child and redirect them but now I look at it and think 'well why did that happen and what is going on?', I look deeply and observe and record more." Anna talked about constructing a tent structure in the room for children to use if they "need to be alone," and Lisa spoke about bringing in "calming toys" like "stressor balls and little fidget things to handle in transition times." Hana referred to changed practices with regards to lighting in the room stating: "We've started dimming the lights. We used to say, 'you can't shut the lights off' when they did it themselves but now I think, 'well maybe light is a stressor and they need that.'"

A third theme that emerged from the qualitative data captures the overall idea that many participants reported having gained new knowledge from the professional learning, specifically in regard to brain science and the role that stress plays in behavior. Many PL participants referred to how important the new information about brain science and the stress response had become to their work. For example, during the site visit Isabelle remarked, "Understanding how the brain works blew me away." Anita commented on how she "didn't know how the brain worked before", and Susan noted how helpful it was to "understand the science of the brain.' Jane summarized these various ideas in her comment, "Understanding and knowing the science of the brain and how one part can't work as well when the stress brain is more active totally changes everything. The brain science now actually gives us the why."

Not only did the professional learning seem to have an impact on teacher beliefs about children's behavior, but it seemed to impact some educators' beliefs about their own behavior and that of those around them as captured in Theme 4. For example, Nora remarked, "Yeah I think now when I feel like I'm acting out in my own way, like I'm frustrated or something I'm now realizing 'Okay, I'm stressed' and that I feel like I'm not focusing on what are my own stressors." During a site visit, Tracy commented, "I see children differently and myself too" and Mishal reiterated this notion when she said, "I've been thinking more about myself than the children to be honest." Similarly, Hana commented, "I'm thinking, 'Oh my gosh why am I so stressed now?' and

realizing that I have my own triggers, the things that make me mad and I try to eliminate those things before it happens now." Jane summed up how the professional learning had impacted her personally: "The training totally changed my life. I can honestly say it has changed all of my relationships … I've changed how I am interpreting what is going on with people."

A fifth and final theme that emerged from the site visit and focus group data related to the quality of the professional learning itself; directly addressing the second research question. Many participant comments provided insight into why the professional learning might have led to significant change in beliefs and practices. For example, Lena commented on the "comfortable" personality of the facilitator. Isabelle extended on this idea, as she admitted: "I went into the training thinking 'not this again' but this was different. It was interesting! You [researcher] were just so passionate and into it." Helen mentioned how the real stories shared by the presenter and participants were "so helpful and meaningful" and Marie commented on the delivery of the scientific information saying, "the way you [researcher] said things really simplified some complicated processes."

Discussion

Changed Beliefs and Practices Regarding Challenging Behavior

While a mixed methods study was utilized as it "honours complexity" (Greene, 2006, p. 97) and offers the potential to examine points of convergence or divergence in the two types of data, in the present study there was considerable convergence of quantitative and qualitative findings. Pre-post analyses of the survey data in this study show that the two-day professional learning course significantly impacted educator reported beliefs and practices in regard to children with challenging behaviors. Specifically, quantitative results showing lower scores for the PL group on the beliefs scale indicate a more contemplative, open, and less "controllable" (i.e., within the control of the child) view of child behavior than before the professional learning. Likewise, lower practices scores for PL participants following the professional learning suggest more thoughtful, individualized, and supportive responses to challenging behavior for this group.

The significant quantitative changes in beliefs and practices may be understood in light of qualitative findings. PL participants frequently commented on their heightened personal stress awareness, exemplified in comments such as, "I think focusing on the children's stress actually brings down my own," and how "focusing on theirs [stress] helped mine" This personal impact (Theme 4) supports the suggestion of Dubinsky et al. (2013), that by improving educator understanding of the neuroscience that impacts the behavior of children, we might ultimately affect how they think about themselves and their own learning. Moreover, this transfer of learning to oneself indicates a high level of learning (Byrnes, 1996) and as such, may underpin the significant change to beliefs and practices found in this study.

Further, educator reports of the new knowledge gained as a result of the professional learning (Theme 3) captured in comments such as "I didn't know how the brain worked before" and, sheds additional light on quantitative results. This reported new learning may have lent to the heightened interest and motivation of participants (Sheridan et al., 2009). It also suggests that the professional learning may represent a viable means to delivering the neuroscience on stress and brain function to educators that has been called for by Blair and Raver (2015) as discussed further below.

Potential Impact on Educator Responsiveness

The change in beliefs to a more open, less judgmental understanding of child behavior, as linked to a change in practice that is more thoughtful and individualized is supported by the findings of Dagnan et al. (1998) and Nungesser and Watkins (2005), that show that the belief that 'misbehavior' is under the control of the child leads to a reactive, punitive educator response. The shift to a belief that challenging behavior might be related to automatic brain processes, is especially significant as it shifts educator attribution of child behavior from being the willful intention of the child, which has been shown to lead to punitive response (McCullough et al., 2019), toward an appreciation of behavior as potentially resulting from a natural response to stress. This idea was captured in one educator's comment that she now understood that a child is not "being bad" when displaying challenging behavior, but rather that they might be excessively "stressed". These results are particularly important in light of Partee et al.'s (2020) recent finding that early educator's perception of classroom behavior as 'disruptive' leads to an overall decline in the quality of their practice.

Effective Professional Learning

The impact of the professional learning on educator beliefs and practices may be further understood in the context of effective professional learning. First, this learning was explicitly introduced as a "sharing of knowledge" experience. It was framed as a learning event whereby the knowledge gained might naturally lead to authentic changes in behavior. This approach serves to promote a partnership between facilitator and participants (Sheridan et al., 2009). Additionally, the personal stories of educators were invited and incorporated into the learning; in many cases used as

starting points to expand upon and apply difficult theoretical concepts. This component of the professional learning reflects the finding of Sheridan et al. (2009) that personal reflection during training for early childhood educators is essential to participant motivation and overall professional learning effectiveness. As noted by Landry et al. (2012), using authentic contexts helps adult learners take responsibility for their learning and can support a more positive relationship between the facilitator and the learner. Through the sharing of experiences and several video and graphic components, the professional learning went beyond simple information giving (Sheridan et al., 2009).

Finally, the content of the professional learning included information on the overall significance of the work of ECEs, referencing empirical research showing how ECEs impact a child's brain development and long-term academic achievement (Hamre & Pianta, 2001; Shonkoff et al., 2009). The impact of this research was evident as many educators noted they did not know that empirical research substantiating the importance of their work existed. Feelings of efficacy that resulted from learning about this research were likely an important motivational force for the deep, personalized learning that occurred in this study (Bandura, 1986). This finding speaks to the importance of incorporating research on the overall value of early years educators in all of their professional learning experiences as a means to promoting engagement (McCullough et al., 2019).

Policy and Practice Implications

While the field of early education has been working to close the gap between recent neuroscience and practice, many front-line educators remain uninformed with regards to important scientific information that might assist them in their daily practice (Ansari et al., 2011; Blair & Raver, 2015). Indeed, in reflecting on this issue, Blair and Raver (2015) called for a "clear and meaningful translation of findings from neurosciences in ways that can remove some of the mystique that surrounds data on brain function and stress" for educators (p. 77). The many references to the science of brain development in site visit and focus group data in this study illustrate PL participants' new knowledge in this area. This finding suggests that the professional learning on the neurophysiology of behavior, as framed by Self-Reg theory, may represent the viable 'translation' of the neuroscience on stress and brain function that has been called for by Blair and Raver (2015). This neuroscientific view of behavior may provide an additional tool for educators in their ongoing efforts to promote self-control and executive functioning skills in children as it explains the link between the stress response system and the functioning of the prefrontal cortex where these critical skills are processed (Diamond & Lee, 2011).

Moreover, this professional learning may also remedy the general need for training in regard to challenging behavior for early years educators (Partee et al., 2020). A survey conducted by Hemmeter et al. (2008) showed that professors working in ECE training programs across nine US states reported a belief that their graduates were not prepared to work with children with challenging behaviors and an earlier study by Hemmeter et al. (2006) found that of all of the training needs identified by 500 surveyed early childhood educators, the need for training to address children with challenging behavior was ranked the highest. Flower et al. (2017) suggest that the under-preparedness of educators in regard to challenging behavior is leading to significant challenges in the profession. As the educators in this study reported a deep understanding of scientific information beyond their traditional realm of training (Shonkoff & Levitt, 2010) and highlighted changes they had subsequently made to their practices regarding challenging behavior of children, this professional learning represents a potential means to addressing this training gap. Finally, that this professional learning shifted educator beliefs and practices to being more emotionally supportive, forwards it as an alternative to traditional learning opportunities that ask educators to adopt a packaged program as a means to improving responsive behaviors, an approach that educators have reportedly grown weary of (Bills et al., 2016; Lightfoot & Frost, 2015).

Conclusion

Given what we know about the importance of student–teacher relationships to a child's developmental and academic outcomes, there is a need to find ways to improve the capacity of early years educators to be emotionally supportive (McNally & Slutsky, 2018), especially in the face of rising rates of children with challenging behavior. There is a simultaneous need to deliver neuroscience to early years educators that is relevant to their practice (Blair & Raver, 2015). In developing a professional learning program that accessibly conveys recent scientific information on child behavior as related to neurophysiological stress, this study addresses both of these challenges as it demonstrates that knowledge regarding the neurophysiological underpinnings of child behavior can shift educator beliefs and practices in an emotionally supportive direction.

There are limitations to this study, such as the survey instrument relying on educator self-report and therefore being subject to respondent bias (Adams & Lawrence, 2015). However, educator comments during site visits and focus groups support a genuine shift in beliefs and practices. Future replications of this study might include observational data in order to substantiate change in educator practice following the professional learning.

Despite these limitations, the findings of this study suggest that widespread professional learning on the neuroscience of child behavior for early childhood educators would be beneficial to their practice and particularly to their understanding and management of challenging behavior. Furthermore, insofar as this neuroscientific knowledge encourages emotionally supportive beliefs and practices, it stands to promote positive student–teacher relationships, increasing the likelihood that all children experience success in the classroom.

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