Understanding Educational Caregivers Accuracy in Detecting Facial Expressions of Pain in Children: An Eye-Tracking Study

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Abstract

Facial expressions of pain are important indicators that an individual needs attention from others. Previous studies have found that different caregiver groups have had difficulty in distinguishing genuine, suppressed and fake pain in children. The current study examines education professionals and their ability to recognize pain expressions in children while their eye-movements were tracked. Eye-tracking was used to understand their accuracy in detecting pain expressions, as well as identifying strategies to improve recognition. Results indicated that participants were more accurate for suppressed than fake expressions, and more for fake than genuine expressions. Results from eye movement patterns offer information on how to improve accuracy upon recognition. For genuine and suppressed expressions, participants must attend to the eye zone longer than the mouth zone. For fake expressions, the mouth zone needs more attention to increase accuracy. Also, when participants spent more time in the eye zone than the mouth zone, their levels of accuracy decreased.

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The ability for individuals to read non-verbal behavior, such as facial expressions, is an important social skill that allows humans to identify what others need as well as their emotions and, allows us to react accordingly (Matsumoto & Hwang, 2011). For example, while in pain our expressions signify to others that we need help. Thus, in order to respond appropriately to a given situation, it is an important skill to be able to recognize the sincerity of pain expressions. The current study analyzed educational professional's ability to accurately recognize genuine, suppressed, and faked facial expressions of pain in children. To the best of our knowledge, no research has examined how well educators perform at this task. Furthermore, by tracking the eye-movements of each participant, this study provided data on the perceptual-attentional processes that are involved in discriminating between pain expressions. More precisely, eye-tracking allowed the observation of differences between where the educational professionals focused their attention in relation to their accuracy in determining the correct facial pain expression.

Production of Facial Pain Expressions

Various studies that have induced pain in participants for the purpose of recording their facial expressions to then analyze muscle activations in pain expressions that occur naturally (Birnie et al., 2012; Boerner et al., 2013; von Baeyer et al., 2005; Wolf & Hardy, 1941). One method to analyzing the expressions is through the use of the Facial Action Coding System (FACS) (Ekman & Friesen, 1978). FACS describes each facial action unit that is displayed as result of facial muscle contractions. For example, with a

genuine expression of pain, research has shown more frequent and intense activations of the lip corner puller, the cheek raiser, the opening of the mouth or a raised upper lip, the eyelids become tighter or the eyes are closed, and nose wrinkling (Hill & Craig, 2002; Larochette et al., 2006). These findings are consistent across adults and children (Bennett & Montgomery, 1999; Breau et al., 2001). Although these types of expressions have been identified and coded, differences in how pain expressions are displayed individually does occur, as well as by the level of their intensity displayed (Craig & Hill, 2002).

The way genuine facial expressions occur has been considered universal (Ekman, 2003). However, along with presenting our expressions naturally, humans are also capable of, suppressing them (Porter & ten Brinke, 2008). Humans may suppress their facial expressions of pain for multiple reasons, and one possible reason for children to suppress their pain expressions is due to fear of negative consequences from their caregivers (Craig & Hill, 2002; Larochette et al., 2006). Suppressed pain expressions are similar to the way genuine facial expressions are displayed, however they are less frequent and intense than when displayed genuinely (Larochette et al., 2006).

Seeing as individuals have the ability to control their expressions, they are also capable of faking their pain (Larochette et al., 2006). Faked pain expressions can occur due to various reasons; some people will fake their pain for a personal benefit or gain, such as in legal matters (Craig & Hill, 2002). Genuine facial expressions and faked facial expressions differ in relation to the frequency and intensity of the facial actions or facial muscle movements (Craig & Hill, 2002). Faked pain expressions are more vigorous, and they usually have a longer duration in comparison to a genuine facial expression (Craig & Hill, 2002). Faked pain expression also result in a decreased rate of eye blinking (Craig &

Hill, 2002), as well as faked pain expressions show the same facial cues as a genuine pain expression, just with a higher intensity (Larochette et al., 2006). Furthermore, research has indicated that faked pain expressions' muscle activation may appear gradually and separately rather than all at once, which is how genuine facial pain expressions occur (Craig & Hill, 2002). Finally, unlike genuine and suppressed facial expressions, faked facial expressions may contain activations associated to other emotional expressions such as shame, guilt or a smile (Hager & Ekman, 1985). This could indicate that although people can recreate different facial expressions, there can be an underlying difficulty in accurately reconstructing the facial expression they are trying to produce.

Recognition of Pain

The ability for caregivers to detect genuine, suppressed, and fake pain expressions is important for proper care and addressing the true needs of children of whom they are in charge. Educational caregivers spend six to eight hours per day with children. Since working with children is their primary job, it is important for the educational caregivers to be able to accurately perceive the level of pain that children are in, as well as determine the authenticity of pain (Logan et al., 2007).

Research has indicated that children have the ability to voluntarily control their expressions of pain much like adults (Boerner et al., 2013). The fear of harmful consequences is one of the primary reasons that children have learned to mask their facial expressions (Boerner et al., 2013; Larochette et al., 2006). Logan et al., (2007) observed how teachers were in response to the chronic and acute levels of pain experienced by children, but did not look at how the teachers were in regards to judging the levels of pain. Logan et al.'s (2007) study relied on the children to verbally explain their pain, as

well as their medical records in determining if they were experiencing pain. However, since pain is a subjective the educators relied on the children to accurately describe their true feelings of pain (Franck et al., 2000).

All caregivers encounter different situations that require them to analyze and react to the expressions of pain that are being displayed by the children they are caring for. However, there has been no research in regards to how educational caregivers are at detecting various types of pain expressions. Other caregivers, such as parents, nurses and doctors have been studied in terms of judging the facial expressions of pain in children (Boerner et al., 2013; Larochette et al., 2006). For instance, nurses had a higher level of accuracy in determine pain expressions over doctors and parents (Larochette et al., 2006). However, out of the three groups of caregivers, parents had a higher accuracy in detecting faked pain expressions over other types of pain expressions (Larochette et al., 2006). These variations could be due the training and education that nurses receive in comparison to doctors, as well as noting that parents tend to have little to no training in recognition of pain unless their profession required the training (Franck et al., 2000). In regards to educational professionals, they may not necessarily be trained on pain recognition in children. If educational professionals have received training, it may vary from school to school. Due to the lack of training, and differences in their job requirements, it is difficult to determine how well educational professionals will be at recognizing pain in children.

The Perceptual-Attentional Limitation Hypothesis

The perceptual-attentional limitations hypothesis proposes that the difficulties in recognition of different pain expressions could be due to difficulties perceiving subtle

changes in facial expressions or lack of attention to the areas of the face that cue in the genuineness or lack thereof of pain expressions. The use of the eye-tracking system allowed the examination of scanning patterns of individuals when viewing genuine, suppressed, or fake pain expressions. These eye movement patterns were examined as a function of accuracy to determine if certain areas of the face were more relevant, such as eyes and mouth, in determining facial expressions in compared to others, such as nose and forehead.

Current Study

Within the current study, we observed eye movements of educational caregivers when they were required to determine whether the children in each video are displaying genuine, suppressed, or faked pain. The current study also examined the educational professional's confidence in their answers, and how much pain they think each child was in. The purpose of this study was to understand how accurate educational caregivers were at detecting when children are experiencing genuine, suppressed, or fake pain, based upon their facial expressions. Furthermore, this study will also examine what specific facial cues the educational caregivers were using when they were trying to determine between genuine, suppressed, and faked pain expressions. As for eye tracking, the current study will further allow the examination of the link between facial exploration and accuracy in pain detection. By examining where it is on the face the participants are viewing that then allows for an accurate judgment. This could lead to a potential explanation on why there are errors in recognition and how to eliminate the risk of errors.

As previously mentioned, no study has examined the judgment of pain expressions in educational professionals. Due to the differences in their job credentials

and personal relationships with the children, it is difficult to determine how educational professionals will perform in comparison to other caregivers such as parents, nurses, and doctors. However, in Larochette et al. (2006) and Boerner et al. (2013), it was found that the caregivers were most accurate at recognizing faked, then suppressed and finally genuine pain expressions. Therefore, based on the previous studies, it was hypothesized that there will be a similar trend with the educational caregivers; as they will be most accurate at detecting faked and suppressed pain expressions over genuine pain expressions.

In regards to the eye-tracking system, and to the best of our knowledge, there have been no studies that have examined the recognition of pain expressions using this technology. Roy-Charland et al., (2014; 2015) had previously found that participants have a higher accuracy in detecting fear expressions over expressions of surprise when the changes between the appearances was greater; as well as when participants were focusing on the appropriate locations of the face. This study hypothesized that errors that occurred in recognizing facial expressions of pain could be accounted for by the participants' difficulties in observing the subtle changes between the three expressions of pain. Errors could also be due to the lack of attention when examining the facial actions of the children in the stimuli. It was also hypothesized that specific areas of the face, such as the mouth and the eye zone, will be important to attend to longer in order to be more accurate at recognizing which facial expression of pain was being displayed. Furthermore, it was hypothesized that these areas on the face that need to be attended to will differ across the type of pain that is being displayed.

Methods

Participants

In the current study, 17 individuals, 3 males and 14 females (*M*age =25.7) were recruited to participate. The 17 individuals were teachers or educational assistants in the educational field, ranging from pre-school to post-secondary education. Upon participation, each individual was asked if they have normal or corrected vision to ensure proper calibration to the eye-tracking system.

Participants were recruited using public advertising such as Facebook posts and shares, posters in the workplace and word of mouth through fellow lab members. Eligibility for participants was dependent upon their background in the educational field. Educational staff that has experience, or excess years of experience with younger children, between the ages of 4-12 years, were strongly considered. This factored into their consideration, as this age range is closest to the children who appear in the video stimuli. Each participant was also asked about the cold pressor task and their familiarity with the task (or lack of knowledge).

Materials

The dynamic facial expressions of pain used in this research were created for the purpose of this study. They consisted of children experiencing genuine, faked, and suppressed pain. To create the genuine and suppressed expressions, a cold pressor task was used. The cold pressor task has been found to be a safe and ethical way to experimental induce levels of pain clinically (von Baeyer et al., 2005). During this task, the children were asked to submerge their right hand in cold water for a minimum of 10 seconds while a camera filmed their facial reactions to the stimulus. In order to fully

capture their initial response, the first attempt was always the genuine condition; this is where the children openly displayed their pain. For the second condition, the children were asked to produce a suppressed pain reaction. In the final condition, the children were asked to produce a faked pain expression by placing their hand into warm water and asked to stimulate what they considered to be a believable expression of pain. Four girls (6.75 years) and three boys (8.6 years) were asked to produce each of these expressions. Each expression was repeated three times for a total of 63 trials.

Each of the 63 videos were approximately 20 seconds in length. Additionally, the audio aspect of each video was removed to minimize the potential for influence of verbal and auditory information (Boerner et al., 2013).

Eye-tracking Apparatus

Participants' eye movements were tracked with the Eyelink 1000 system from SR Research Ltd. The Eyelink 1000 consists of a camera and an infrared sensor. Both of these were positioned in front of the computer that displayed the stimuli. In the current study, the participants' right eye was tracked. The experimental data obtained was then transferred from the Eyelink 1000 to the computer displaying the experimental videos via an Ethernet connection (Roy-Charland et al., 2014).

Procedure

Participation in this study required each participant to sit through a 45 to 60 minutes testing session. Each session took place in the Cognitive Health Research Laboratory at Laurentian University, Sudbury. Once they signed the consent form, they were asked to complete a demographics questionnaire.

The Eyelink 1000 was then calibrated and the participants were instructed that they would view 63 videos, each approximately 20 seconds in length, showing children expressing one of three types of pain expressions: genuine, suppressed, or faked. All of the experimental conditions were defined as: the genuine condition, where the child is indicating pain felt in reaction to their hand being placed in the cold water; the suppressed condition, where the child is hiding their pain in reaction to the cold water; the faked condition, where the child is faking to be in pain while their hand is placed in warm water.

Videos were displayed in a randomized order for each participant. Each video was followed by three questions presented on the screen. They were first asked to identify which expression they believed the child was experiencing. Secondly, they were asked to rate how confident they were in their judgment using a Likert Scale, 0 (not at all confident) to 10 (extremely confident). Thirdly, they were asked to estimate the level of pain intensity felt by each child using the Facial Pain-Scale Revised (FPS-R) (Hicks et al., 2001), which used a six-point face scale ranging from “no pain” to “very much pain”. The experimenter stressed that the goal was not to match the child’s facial expression, but rather to select the facial expression that corresponds best to the estimated level of pain that the participant believed the child is feeling (Boerner et al., 2013). These questions required the participants to answer verbally, while the experimenter wrote the answers.

Upon completion, participants were asked to fill out a questionnaire pertaining to which facial cues they thought that they used when making their judgments. These three questions were open-ended and asked the participants to indicate which parts of the face, that they are aware of, that they generally used to determine the authenticity, suppression,

and stimulation of the pain expressions displayed by the children (Boerner et al., 2013). Once the questionnaire was completed, the participants were debriefed.

Data Analysis

Percentage of accurate responses were computed by dividing the number of correct responses per number of trails for each expression type, 21 trials of genuine pain, faked pain and suppressed pain, average scores for each expression type were then used in analysis. Confidence levels for each participant were rated using the Likert Scale ranging from 0-10, and pain levels were rated using the FPS-R (Hicks et al., 2001), which used a scale ranging from 0-5. Analysis using a repeated-measures ANOVA were conducted using the types of pain (genuine, faked and suppressed) as between- and within-subject factors respectively.

For eye-movements, proportion of time in each zone (eyes vs. mouth) was examined. A 2 (eyes vs. mouth) X 3 (genuine, fake and suppressed) X 2 (accurate vs. inaccurate) ANOVA was then conducted to examine the attention to each zone respectively, expressions and accuracy. Proportion of time zone computed by dividing the time spent in the eye or mouth zone, by the total time spent watching the video. Analyses were then computed for the timing of initial orientation to zone using a 2 (eyes vs. mouth) X 3 (genuine, fake and suppressed) X 2 (accurate vs. inaccurate) ANOVA.

Timing of initial orientation for the eye and mouth zones were measured from the onset of the stimulus, when the video appeared on screen, until the participant's first fixation in the corresponding areas, eye or mouth zones (Roy-Charland et al., 2016). To compute this measure, there must be a least one fixation occurring in the eye or mouth zone. In addition to the zones (eyes and mouth), expression of pain (genuine, faked and

suppressed) was used as an independent variable. For the first stage in analysis accuracy was used as a dependent variable, for the eye-tracking data, accuracy was then used as an independent variable (Roy-Charland et al., 2007).

Lastly, a Pearson correlation was conducted to analyze if there were any correlations present between accuracy, level of confidence and pain level in regards to each type of pain expressions (genuine, faked, suppressed).

Results

Accuracy

The percentage of accurate responses was examined as a function of expression type (genuine, fake, and suppressed). Means and standard deviations are presented in Table 1. The repeated-measures ANOVA revealed a significant effect of expression type, ($F(2,32) = 24.57$, $p < .001$, $\eta 2p = .61$). Post hocs (LSD) revealed that participants were more accurate for suppressed expressions than the other two types of expression; and were better at detecting fake than genuine expressions.

An analysis was also computed for each of the three types of expressions (genuine, fake and suppressed) to compare obtained accuracy of recognition with chance level. Since three options were available to participants, chance level (alpha) was set at 33%. For fake and suppressed expressions, respectively, accuracy was better than chance ($t(16) = 3.42$, $p < .005$, $t(16) = 7.10$, $p < .001$). For genuine expressions, accuracy did not differ from chance level, ($t(16) = -.05$, $p = .96$).

Level of confidence

As for accuracy, the level of confidence was analyzed as function of expression type (genuine, fake and suppressed). Means and standard deviations are presented in

Table 2. The repeated-measures ANOVA revealed a significant effect of expression type ($F(2,32) = 5.59$, $p = .008$, $\eta^2_p = .260$). Post hoc tests (LSD) revealed that participants were more confident in detecting fake and genuine expressions than suppressed expressions.

Level of pain

The level of pain was examined as a function of expression type (genuine, fake and suppressed). Means and standard deviations are presented in Table 3. The repeated-measures ANOVA revealed no significant differences based on pain type, ($F(2,32) = .744$, $p < .48$, $\eta^2_p = .04$).

Eye movements

Proportion of time in zones. The proportion of time spent in each zone (eyes vs. mouth) was examined as a function of expression type (genuine, fake and suppressed) and accuracy (accurate vs. inaccurate). Means and standard deviations are presented in Table 4. The 2 (eyes vs. mouth) X 3 (genuine, fake and suppressed) X 2 (accurate vs. inaccurate) ANOVA revealed no main effect of expression type, ($F(2,30) = 3.14$, $p = .06$), accuracy, ($F(2,30) = .591$, $p = .45$), or zone, ($F(2,30) = 4.15$, $p = .06$) was significant. There were two-way interactions between zone and expression type, ($F(2,30) = 14.41$, $p < .001$, $\eta^2_p = .49$), and between zone and accuracy, ($F(2,30) = 15.01$, $p = .001$, $\eta^2_p = .50$). None of the other interactions were significant (all $Fs < .56$, $ps > .58$).

Simple main effects tests were computed to examine the interactions. For the interaction between zone and expression type, Dunn-corrected pairwise comparisons were applied with alpha level set at .03. For the eyes zone, there was a significant effect of expression type, ($F(2,32) = 13.56$, $p < .001$, $\eta^2_p = .46$). Results revealed that less time was spent in the eyes for fake expressions than the other two, which did not differ

significantly for each other. For the mouth zone, there was also a significant effect of expression type, ($F(2,32) = 20.35$, $p < .001$, $\eta^2_p = .56$). Results revealed that less time was spent in the mouth for suppressed expressions than the other two and less time was spent in the mouth for genuine than for fake. For genuine and fake expressions, there was no difference between zones, ($F(1,16) = 4.42$, $p = .05$, $F(1,16) = 1.08$, $p = .32$). However, for suppressed expressions, participants spent more time in the eyes than mouth ($F(1,16) = 8.43$, $p = .01$, $\eta^2_p = .35$).

Second for the interaction between zone and accuracy, Dunn's correction was also applied to alpha level ($p < .04$). For accurate and inaccurate responses, respectively, participants did not significantly spend more time in one zone over the other, ($F(1,16) = 3.47$, $p = .08$; $F(1,16) = 4.98$, $p = .04$). For the eyes zone, participants spent more time for inaccurate than accurate response, ($F(1,16) = 5.23$, $p = .036$, $\eta^2_p = .25$). However, for the mouth zone, there was no significant difference between accurate and inaccurate responses, ($F(1,16) = 1.79$, $p = .20$).

Timing of initial orientation to zone. The timing of the initial orientation to each zone (eyes vs. mouth) was computed as a function of expression type (genuine, fake and suppressed) and accuracy (accurate vs. inaccurate). Means and standard deviations are presented in Table 5. The 2 (eyes vs. mouth) X 3 (genuine, fake and suppressed) X 2 (accurate vs. inaccurate) ANOVA revealed a main effect of zone, ($F(1,14) = 6.26$, $p = .025$, $\eta^2_p = .309$), and none of the other main effects were significant, all $Fs < .749$, $ps > .401$. There was a two-way interaction between zone and expression, ($F(2,28) = 7.53$, $p < .002$, $\eta^2_p = .350$). None of the other interactions were significant, all $Fs < .594$, $ps > .5593$.

Simple main effects tests were computed to examine the interactions. For the interaction between zone and expression type, Dunn-corrected pairwise comparisons were applied with alpha level set at .03. For the eyes zone, there was no significant effect of expression type, ($F(2,32) = 1.89$, $p = .17$). However, for the mouth zone, there was a significant effect of expression type, ($F(2,32) = 10.31$, $p < .001$, $\eta^2_p = .39$). Results revealed that participants are faster to look at the mouth for fake expressions than the other two types that did not differ significantly. For genuine and suppressed expressions, participants were faster at looking at the eyes than the mouth, ($F(1,16) = 13.52$, $p = .002$, $\eta^2_p = .46$; $F(1,16) = 8.46$, $p = .01$, $\eta^2_p = .35$). However, there were no difference between zones for fake expressions ($F(1,16) = 3.71$, $p = .07$).

Correlations

Correlations were computed between accuracy, level of confidence and pain level for each type of expressions (genuine, fake and suppressed). However, there was no significant correlation between any of the measures, all $rs < .44$, $ps > .08$.

Discussion

The current study examined educational professionals' ability to recognize facial expressions of genuine, suppressed, and faked facial expressions of pain in children while their eye-movements were tracked. Educational professionals' accuracy was examined to determine which type of pain expression was detected most accurately. Furthermore, each participants' confidence levels were examined for each type of pain expression, as well as how much pain they rated the children to be in. However, the main purpose of this study was to examine the eye-movements of educational professionals while they

were viewing the videos to determine where they were looking at on the face of each child before they gave their response. Furthermore, eye-movement patterns were observed to examine if they differed based on the individuals' level of accuracy. Previous research has indicated that caregiver's ability to detect pain expressions in children has indicated that the task is generally performed at chance level (Boerner et al. 2013). Due to this difficulty, results from the current study reveal that there are certain areas of the face that caregivers should focus on in order to increase accuracy. Hence, the goal of this study was to further understand the accuracies and errors in regards to pain detection in order to allow for improvement in regards to recognizing different facial expressions of pain.

Accuracy across pain conditions

Accuracy was examined across each type of pain expression in the interest of determining which pain expression was recognized most accurately by the educational professionals. Results revealed that participants were most accurate at detecting suppressed pain expressions compared to genuine and fake. These results are similar to those found in Boerner et al. (2013) and Larochette et al. (2006) who found that participants were most accurate at detecting suppressed and fake expressions of pain over genuine expressions. The current study's results indicated, that like Boerner et al. (2013), participants of a different population were better at detecting suppressed expressions than fake expressions, and better at fake expressions than genuine expressions. Boerner et al. (2013) found that participants were most accurate at detecting fake expressions pain than suppressed expressions, and suppressed expressions than genuine expressions. With

nurses being the most accurate at detecting facial expressions of pain compared to parents and doctors.

Furthermore, Boerner et al. (2013), examined the ability of caregivers to detect pain expressions in children, and if the task is performed at or near chance level. The current study found that participants performed better than chance level for suppressed and faked expressions but not genuine. Thus, unlike Boerner et al. (2013), the educational professionals are not as accurate as the caregiver's they examined in regards to detecting pain expressions above chance level. The differences between accuracy of caregivers could be due to the types of training that they could receive for the professions.

Confidence Ratings

The participants' level of confidence in their decision making was recorded for each video they viewed. Overall, educational professionals were found to be more confident when they thought the child was displaying fake pain and genuine expressions and less confidence for suppressed expressions. Confidence was not found be related to accuracy as participants were more confident in fake pain expressions, however they were not as accurate for this expression type. Participants were also least confident when choosing suppressed for their response, even though they were most accurate for this expression type. This suggests that level of confidence is not a good indicator of accuracy for this task. These results are similar to those from Ekman and O'Sullivan (1991), which found that confidence levels were not significantly related to the accuracy of detecting lies. Therefore, regardless of training and experience in certain employment fields, confidence levels may not match accuracy levels.

Pain Ratings

Along with type of pain expression and confidence levels, participants were asked to rate each child's level of pain. Results revealed that there were no significant differences in how participants rated the children's pain based on pain type. Therefore, regardless of which pain expression was being displayed by the children, educational professionals rated each pain type similarly to the others. Since the participants were not viewing any differences between pain types that were being displayed by the children, it raises a concern that people are not able to accurately determine how much pain a child is in. Boerner et al. (2013) found that caregivers underestimated suppressed expressions more frequently than they overestimated how much pain they believed the children to be in. It was also found that caregivers underestimated pain more frequently when viewing genuine and suppressed expressions than for fake expressions. The current studies results are similar to those by Boerner et al. (2013), educational professionals tend to underestimate suppressed pain more than the other two types of pain.

Eye-movements

The current study examined the eye-movements of educational professionals to further understand how the areas on the face, eye zone, and mouth zone, were related to their accuracies in pain judgement. Proportion of time spent in the eye zone and mouth zone were examined, as well as timing of initial orientation to zone. In examining the proportion of time spent in the eye and mouth zones, results revealed that participants were less likely to spend time in the eye zone for fake expressions in comparison to genuine and suppressed expressions. Whereas, for suppressed expressions the participants spent less time looking at the mouth zone. Furthermore, for fake and genuine

expressions results revealed that there was no significant difference between the two zones. However, for suppressed expressions, participants looked at the eye zone longer than they looked at the mouth zone.

Nonetheless, the results that were most interesting related to the interaction between zone and accuracy. These results showed that when participants looked in the eye zone more than the mouth zone, the less accurate they were in their responses for genuine and fake expressions of pain. For fake expressions of pain, they require the participants to look more at the mouth zone than the eye zone to increase accuracy; but in the current they spent more time in the eye zone than the latter. Thus, participants have a bias towards the eye zone, even when fake expressions require more time in the mouth zone to accurately detect the facial expression. For genuine expressions, there were no differences between the eye zone and mouth zone. Whereas for suppressed expressions, participants spent more time in the mouth zone. However, accuracy results showed that participants need to spend less time in the eye zone to properly recognize the expression.

As for timing of orientation, a pattern emerged for each of the three expressions. For fake expressions, participants were faster to look at the mouth zone over the eye zone. Whereas for genuine and suppressed expressions, participants were faster to look at the eye zone over the mouth zone. For suppressed expressions participants were faster to look at the eyes, but spent more time in the mouth zone, therefore even though they spent time in both zones, they were spending more time in the eye zone than the other two expressions, which helped them more accurately detect the facial expression being displayed. Whereas for fake expressions, participants were spending more time in the mouth zone over the eye zone, but were still spending almost an equal amount of time

between both zones, thus making them more accurate than genuine expressions. Therefore, these results support our findings for accuracy levels as participants orientated towards the mouth zone primarily over the eye zone for genuine expressions, thus explaining why genuine expressions were the least accurately recognized out of the three expression types.

The results for the eye movements revealed an interesting pattern to help understand both the errors, and how to improve accuracy. Overall, results suggested that the longer participants spend looking in the eye zone in relation to the mouth zone, the less accurate their responses for fake and genuine expressions. From the results, it was observed that for suppressed expressions it was important for the participants to look at the eye zone over the mouth zone to increase accuracy. However, for fake expressions results indicated that in order to increase accuracy, the participants need to spend more time looking at the mouth zone instead of the eye zone. Overall, it was seen that participants had a bias to the eye zone when viewing expressions, even though fake expressions required more attention to the mouth zone. This bias to the eye zone could have been a contributing negative factor in accurately recognizing fake and genuine expressions.

Limitations

A limitation of the current study is that the educational professionals who participated in this study were not specifically involved with children between the ages of 4-10 daily, or had they spent most of their professionals' years as an educator working with this age group. Some of the educational professionals who participated in our study spent most of their time working with children below the age of 5, as they were involved

in early childhood education. Whereas, another large portion of participants spent their time working with children in primary levels, grades 1-7. However, there were also participants who spent time working primarily with children older than those presented in our stimuli. As well as most of our educational professionals were educational or teaching assistants, meaning that they aid the teachers and may not be the first individual that a child comes to when in pain, so they might not have a lot of experience compared to teachers. This in turn, could have affected the results as the educational professionals who worked most frequently with older children or adolescents, could have had a more difficult time examining the facial expressions of children.

Therefore, future research could include a larger sample size of educational professionals. Future research could also include focusing on educational professionals that work primarily with the age group that is presented in the stimuli. As well as examining other caregiver groups such police officers. Police officers may not typically classify as a caregiver, but they do encounter children when it comes to legal cases. Therefore, it would be an important group to explore as it could help determine future custody or abused cases in regards to if the children are in good hands, as well as if they are being abused or faking their pain due to their parents trying to win custody over the other.

Conclusion

The goal of the current study was to examine educational professionals' ability to recognize genuine, fake, and suppressed pain expressions while tracking their eye-movements in order to understand accuracy when performing this task. Results showed that participants were most accurate for suppressed than fake expressions, and more for

fake than genuine expressions. Most importantly, the results that were obtained from the eye-movement patterns offer clues on how to improve accuracy. For fake expressions, it is important that the mouth zone receives more attention to increase levels of accuracy; the faster participants looked at the mouth zone, the higher the accuracy. Whereas, for genuine and suppressed expressions, it is important that the eye zone receives more attention to increase levels of accuracy. With the information obtained from this study on how to improve accuracy for detecting expressions of pain, training programs could begin to be tested with educational professionals to aid in improving recognition, as well as accurately detecting levels of pain the children are in. Facial cues remain the most frequently used nonverbal signals to recognize pain (Craig, 1998; Larochette et al., 2006), therefore working towards improvement for this task is important and necessary to be able to accurately respond to situations in which children are experiencing or expressing pain.

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Expression Type	M	SD
Genuine	32.77	17.32
Faked	46.22	15.95
Suppressed	65.27	18.73

Table 1. Percentage of correct responses as a function of expression type.

Expression Type	M	SD
Genuine	6.54	1.31
Faked	6.60	1.40
Suppressed	6.29	1.24

Table 2. Level of confidence as a function of expression type.

Expression Type	M	SD
Genuine	1.90	0.68
Faked	1.85	0.88
Suppressed	1.71	0.74

Table 3. Level of pain (FPS-R) as a function of expression type.

Expression Type	Zone	Accuracy	M	SD
Genuine	Eyes	Accurate	0.46	0.20
Genuine	Eyes	Inaccurate	0.50	0.24
Faked	Eyes	Accurate	0.38	0.23
Faked	Eyes	Inaccurate	0.47	0.24
Suppressed	Eyes	Accurate	0.50	0.24
Suppressed	Eyes	Inaccurate	0.50	0.25
Genuine	Mouth	Accurate	0.30	0.19
Genuine	Mouth	Inaccurate	0.27	0.17
Faked	Mouth	Accurate	0.34	0.18
Faked	Mouth	Inaccurate	0.29	0.18
Suppressed	Mouth	Accurate	0.23	0.16
Suppressed	Mouth	Inaccurate	0.22	0.17

Table 4. The proportion of time spent in the eye zone and mouth zone as a function of expression type and accuracy.

Expression Type	Zone	Accuracy	M	SD
Genuine	Eyes	Accurate	876.83	1030.46
Genuine	Eyes	Inaccurate	694.82	804.95
Faked	Eyes	Accurate	153.58	1714.40
Faked	Eyes	Inaccurate	748.87	791.30
Suppressed	Eyes	Accurate	708.35	466.53
Suppressed	Eyes	Inaccurate	1507.16	2087.81
Genuine	Mouth	Accurate	2453.41	2034.68
Genuine	Mouth	Inaccurate	2590.55	1558.47
Faked	Mouth	Accurate	1318.03	827.73
Faked	Mouth	Inaccurate	1849.55	1176.06
Suppressed	Mouth	Accurate	2246.71	1478.97
Suppressed	Mouth	Inaccurate	2234.59	1694.20

Table 5. The timing of initial orientation to eye zone and mouth zone as a function of expression type and accuracy.