

EXPLORING THE EXPLICIT KNOWLEDGE OF THE DUCHENNE MARKER AND  
ASYMMETRY IN SMILE JUDGMENT

by

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### **Abstract**

Research has shown that individuals are sensitive to the activation of the *orbicularis oculi* muscle (Duchenne marker) and are able to detect asymmetry. It has been proposed that the differences in smile judgment performance might be explained by one's explicit knowledge regarding the morphological cues. The goal of the study was to explore individuals' explicit knowledge of the Duchenne marker and asymmetry in smile judgment tasks. The present study also employed the Likert scale to examine the possible effect of response options on smile judgment tasks. Participants also were asked to judge both the happiness and authenticity of smiles. Three types of smiles (symmetrical Duchenne, non-Duchenne and asymmetrical) were presented for the smile judgment task. Participants were also asked to indicate if they noticed symmetrical differences and cues in certain facial regions. Results showed that the symmetrical Duchenne smiles were judged as being the most happy and authentic. This was followed by the non-Duchenne smiles while the asymmetrical smiles were judged as being the least happy and authentic. This finding was similar to that found in a previous study that employed the Likert scale, suggesting the possible influence of response options on smile judgment. Similar results were obtained for both the happiness and authenticity judgment conditions, implying that wording only had a minor influence on smile judgment. Results also revealed that participants had good explicit knowledge about the morphological cues but it was not perfect. Therefore, the results suggested that explicit knowledge on its own is not sufficient to explain smile judgment performance.

*Key words:* Authenticity of smiles, Explicit knowledge, Response options, Instructional effects

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### **Exploring the Explicit Knowledge of the Duchenne Marker and Asymmetry in Smile Judgment**

The smile is a form of facial expression that is observable in humans in all developmental stages, beginning from as early as the newborn stage (Cecchini, Baroni, di Vito, & Lai, 2011). It is generally perceived to be a sign of happiness and could be useful in establishing positive social relationships due to the positive attributes associated with smiling, such as generosity (Mehu, Little, & Dunbar, 2008), kindness (Otta, Lira, Delavati, Cesar, and Pires, 1994) and trustworthiness (Scharlemann, Eckel, Kacelnik, & Wilson, 2001). It has been proposed that facial expressions can be produced due to emotional experiences or be produced deliberately through the voluntary control of facial muscles (Ekman, Roper, & Hager, 1980). This ties in with the notion that not all smiles reflect true enjoyment and that they are sometimes used to conceal other emotions, such as embarrassment, sadness, and discomfort, or to indicate politeness (Ansfield, 2007; Ekman, 2001; Hasada, 1996). Studies have found that several morphological features, such as the Duchenne marker (Ekman, Friesen, & O'Sullivan, 1988) and symmetry (Hager & Ekman, 1985), can differ between enjoyment and non-enjoyment smiles and these features have therefore been proposed to be cues that can help distinguish an enjoyment smile from a non-enjoyment smile (Ekman, Davidson, & Friesen, 1990; Ekman, Hager, & Friesen, 1981). Research has shown that participants had difficulty in judging the sincerity of smiles containing these cues (Frank, Ekman & Friesen, 1993; Gosselin, Perron, Legault, & Campanella, 2002). One of the proposed explanations for this difficulty in the judgment of smiles is that it is due to perceptual difficulties in perceiving the cues in smiles (Gosselin et al., 2002) but the eye movement data from a recent study showed that the processing of the smiles were different based on the presence of the cues of non-enjoyment smiles, rejecting the notion that humans

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are unable to perceive these cues in smiles (Perron & Roy-Charland, 2013). Nonetheless, it remains unclear if the judgment of smiles as being authentic is less consistent because the cues are subtle and thus, while perceived, they are still overridden by the more salient markers of authenticity; because most humans are not consciously aware of the changes in morphology of smiles; or because individuals do not interpret these signs as non-enjoyment cues. Therefore, this study aims to examine explicit knowledge regarding the Duchenne marker and symmetry to yield a better understanding of the role of these morphological cues in the judgment of smile authenticity.

### **Duchenne marker**

The Duchenne marker is one of the most commonly explored morphological features in studies examining enjoyment smiles. It involves the activation of Action Unit 6 (AU6) according to the Facial Action Coding System (FACS) or the contraction of the *orbicularis oculi* muscle, which raises the cheeks and usually leads to crows' feet or wrinkles at the corners of the eyes (Ekman & Friesen, 1978; Ekman, Friesen, & Hager, 2002). Duchenne de Boulogne (1862/1990) was the first to point out that enjoyment smiles involve the contraction of the *orbicularis oculi* muscle and *zygomaticus major* muscle, which raises the corners of the lips and stretches the lips sideways (Ekman & Friesen, 1978). The latter is also known as Action Unit 12 (AU12) according to the FACS or the Lip Corner Puller (Ekman et al., 2002). The simultaneous activation of the *orbicularis oculi* and *zygomaticus major* muscles was later being referred to as a Duchenne smile (Ekman, 1989). Evidence supports the notion that people who exhibited Duchenne smiles have reported experiencing greater happiness (Ekman et al., 1990; Johnson, Waugh, & Fredrickson, 2010; Soussignan, 2002). Consistent with the idea that the Duchenne smile signifies true enjoyment, a study by Ekman and colleagues (1988) showed that people displayed more Duchenne smiles when they reported feeling

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pleasant than when they were experiencing strong negative emotions but pretending to exhibit feelings of pleasantness.

However, research has also found that people are able to deliberately activate the Duchenne marker without the apparent need for the expression to be elicited by feelings of enjoyment (Ekman and Davidson, 1993; Gosselin, Perron, & Beaupré, 2010; Schmidt, Ambadar, Cohn, & Reed, 2006; Schmidt, Bhattacharya, & Denlinger, 2009). For instance, a recent study by Gunnery, Hall, and Ruben (2013) revealed that 71% of their participants, when being asked to imitate Duchenne smiles, were able to successfully mimic them. Nonetheless, when these participants were not explicitly told to imitate the Duchenne smiles, only 28% of them displayed Duchenne smiles (Gunnery et al., 2013), which suggests that even if Duchenne smiles can be produced voluntarily, people do not actively produce them in real life situations that do not involve positive feelings. In other words, Duchenne smiles appear to be more common when there is underlying happiness than when participants are instructed to smile.

### **Symmetry of smiles**

The symmetry of facial expressions while smiling is another morphological feature that has been proposed to differ between an enjoyment smile and a non-enjoyment smile. Early reviews of the literature reported that facial expressions tend to be more intense on the left side the face (Borod, Haywood, & Koff, 1997; Skinner & Mullen, 1991). However, this bias towards the left side of the face when producing facial expressions appeared to be more evident for negative emotions than positive emotions (Borod et al., 1997). When the symmetry of smiles was examined, it was found that the voluntarily produced smiles were more likely to be asymmetrical than smiles that were produced spontaneously (Ekman et al., 1981), which is consistent with the finding that the level of asymmetry tends to be higher in voluntary than emotion-elicited facial expressions (Skinner & Mullen, 1991). Indeed, it has

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been found that the smiles produced by both children and adults in response to jokes were more symmetrical than the smiles produced upon request (Hager & Ekman, 1985). On the other hand, some recent studies by Schmidt and colleagues (2006; 2009) reported an absence of significant differences in the symmetry between spontaneous and deliberate smiles. No stimuli or events were incorporated to elicit positive emotions in these studies and the smiles were labeled as spontaneous as long as they were displayed during the course of the experiment in the absence of the researchers' requests (Schmidt et al., 2006; Schmidt et al., 2009). Consequently, the failure to detect any symmetrical differences could be related to the fact that the spontaneous smiles that were not induced by positive stimuli were produced voluntarily without underlying happiness. Despite the conflicting results from recent studies, the evidence seems to support the notion that enjoyment smiles are more symmetrical than smiles that are produced deliberately.

In short, studies on the expression of smiles that examined the Duchenne marker and symmetry have found that smiles can either be elicited by emotions or be produced voluntarily in the absence of underlying positive emotions (Gunnery et al., 2013; Hager & Ekman, 1985). Even though the Duchenne marker and symmetry have been proposed to be two important markers that can be used to distinguish enjoyment from non-enjoyment smiles, they do not necessarily reflect enjoyment smiles at all times. In spite of this, a Duchenne smile and a symmetrical smile are most likely to be produced in response to positive felt emotions.

### **Sensitivity to the Duchenne marker**

Seeing as enjoyment smiles generally contain the Duchenne marker, researchers were interested in the interpretation of Duchenne smiles in observers and sensitivity towards the presence of the Duchenne marker in smiles. Some studies found that Duchenne smiles were linked to positive traits such as intelligence (Quadflieg, Vermeulen, & Rossion, 2013) and

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generosity (Mehu, Little, & Dunbar, 2007), and individuals displaying Duchenne smiles were viewed as being more pleasant and likeable than those displaying non-Duchenne smiles (Frank et al., 1993; Johnston, Miles, & Macrae, 2010). More importantly, studies have also shown that adults tend to perceive Duchenne smiles as being more genuine than non-Duchenne smiles (Calvo, Gutiérrez-García, Averó, & Lundqvist, 2013; Miles & Johnston, 2007; Quadflieg et al., 2013). Similarly, Thibault, Gosselin, Brunel, & Hess (2009) found that the children in their study also had the tendency to rate Duchenne smiles as being more authentic than non-Duchenne smiles, supporting the notion that Duchenne smiles are viewed as being more genuine than non-Duchenne smiles. On the contrary, Thibault, Levesque, Gosselin, & Hess (2012) found that the Gabonese and Chinese participants in their studies did not perceive Duchenne smiles as more authentic when viewing smiles that were exhibited by Gabonese and Chinese people, suggesting that the Duchenne marker might not be seen as a reflection of authenticity in all cultures. Nonetheless, when the smiles were exhibited by French-Canadians, the Chinese participants rated the Duchenne smiles as more authentic than non-Duchenne smiles (Thibault et al., 2012). This indicated that although Duchenne smiles might not be perceived in the same way in certain cultures, they are still linked to higher authenticity in the western culture.

Research has shown that people tend to perceive Duchenne smiles as more genuine; this implies that people have some ability to differentiate between Duchenne and non-Duchenne smiles. Indeed, studies have shown that people performed better than chance level at differentiating between Duchenne and non-Duchenne smiles (Calvo et al., 2013; Gosselin et al., 2002; Miles & Johnston, 2007; Perron & Roy-Charland, 2013; Slessor, Miles, Bull, & Phillips, 2010) and this ability has also been observed in children as young as six and seven years old (Gosselin, Perron, & Maassarani, 2010). Upon closer examination, Gosselin and colleagues (2002) found that more than half of the adult participants in their study managed

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to report facial changes related to the Duchenne marker when asked a free-response question that required them to identify the facial regions that differed between smiles that reflected genuine happiness and smiles that reflected non-genuine happiness, indicating that adults have some explicit knowledge about the Duchenne marker. This ability to detect the Duchenne marker, together with the finding that the Duchenne marker reflects higher levels of authenticity, allows for the use of the Duchenne marker in the judgment of smile authenticity.

There are a few studies that suggest that the judgment of smile authenticity is not always consistent. First of all, the varying levels of constancy in judging a Duchenne smile as being genuine has led to the suggestion that there are individual differences in the judgment of smile authenticity (Manera, Del Giudice, Grandi, & Colle, 2011). Apart from that, Frank et al. (1993) found that Duchenne smiles with low intensity were being judged as genuine only around half of the time, suggesting that there might be some difficulties associated with the judgment of smile authenticity when the smile is weak. Another study found that there was a higher tendency for non-Duchenne smiles to be seen as reflecting happiness if the mouth region of a stimulus was fixated earlier than the eye regions, which implied that initial fixation could influence our perception of non-Duchenne smiles (Calvo et al., 2013) and might partly explain why the individuals who exhibited non-Duchenne smiles in Miles and Johnston's (2007) study were viewed as experiencing happiness more than half of the time. Apart from that, it has been suggested that an individual's basic physiognomy at rest might also influence smile judgments (Quadflieg et al., 2013). Thus, despite the evidence that the Duchenne smiles are generally viewed as being more authentic, there appear to be several factors that could potentially influence the judgment of smile authenticity.

### **Sensitivity to symmetry**

Previous studies have reported that symmetrical Duchenne smiles were perceived as happier than asymmetrical Duchenne smiles (Krumhuber & Manstead, 2009; Perron & Roy-Charland, 2013). On the other hand, Gosselin et al. (2002) reported that neither the adults nor the children in their study viewed the symmetrical smiles as being happier than their non-symmetrical counterparts. The finding that asymmetrical Duchenne smiles, despite being seen as less happy when compared to the symmetrical Duchenne smiles, were viewed as reflecting true happiness most of the time (Perron & Roy-Charland, 2013) further complicated the interpretation of the results. These inconsistent and complex findings suggested that some difficulties might exist in either the detection or the interpretation of symmetry.

When children from the ages of 6 to 7 and from the ages of 9 to 10 were asked to differentiate between symmetrical and asymmetrical smiles, it was found that their performance was above chance level (Gosselin et al., 2010), implying that the difficulty associated with the judgment of smile authenticity is unlikely to be due to the inability to detect the differences between symmetrical and asymmetrical smiles. Further support for the notion that people are able to detect the differences between symmetrical and asymmetrical smiles derived from the eye movement results from a recent study that showed that participants made more saccades from one side of the face to the other while viewing the asymmetrical smiles than symmetrical smiles, which indicated that symmetrical smiles were being processed differently from asymmetrical smiles (Perron & Roy-Charland, 2013). These studies appear to suggest that the difficulty associated with the judgment of smile authenticity does not lie in the detection of symmetry. However, when participants were asked to state the differences between enjoyment and non-enjoyment smiles, only one adult participant listed symmetry as being a distinguishing component (Gosselin et al., 2002). This suggested that

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some people might have difficulty in the interpretation of symmetry or might not view asymmetrical smiles as being less genuine. In addition, it is possible that the presence of the Duchenne marker, which is more consistently viewed to be a marker of authentic smiles, could have affected the judgment of the authenticity of asymmetrical smiles (Perron & Roy-Charland, 2013). In short, the results derived from research seem to suggest that the inconsistencies found in studies looking at the judgment of smile authenticity are more likely to be due to difficulties in the interpretation of symmetry than difficulties in the detection of symmetry.

### **Perceptual-attentional factors**

One of the factors that has been proposed to explain the difficulties in distinguishing between enjoyment and non-enjoyment smiles is associated with limitations in perceptual-attentional processing (Boraston, Corden, Miles, Skuse, & Blakemore, 2008). Attentional limitations, such as directing insufficient attention towards features of the face that contain cues for distinguishing enjoyment from non-enjoyment smiles, can lead to difficulties in the judgment of smile authenticity (Manera et al., 2011). According to this hypothesis, several perceptual limitations also contribute to difficulties in smile judgment tasks. For example, it has been proposed that difficulties in the judgment of smile authenticity might be explained by the failure to perceive facial changes, especially when these are too subtle (Del Giudice & Colle, 2007). Following this explanation, it is possible that the asymmetrical smiles were mainly judged as being really happy in Gosselin et al.'s (2002) study because the differences between symmetrical and asymmetrical smiles were too subtle to be detected. Another perceptual limitation that has been proposed to influence the smile judgment task is the insensitivity to the incongruence between the eyes and the smile as a whole (Del Giudice & Colle, 2007). For instance, faces exhibiting the Duchenne marker along with smiles would be considered congruent whereas faces exhibiting smiles in the absence of the Duchenne marker

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would be considered incongruent (Del Giudice & Colle, 2007). Therefore, someone who has difficulty detecting the incongruence between the eyes and the smile might be less consistent in judging the smile authenticity of faces with incongruent eyes and smiles. Taken together, the perceptual-attentional hypothesis implies that the amount of attention devoted to the morphological cues, ability to detect the cues, and ability to detect incongruence between the cues would be related to the differential performance in the smile judgment task (Manera et al., 2011).

Gosselin et al. (2002) carried out a study in which participants were presented with videoclips of people exhibiting symmetrical Duchenne smiles, asymmetrical Duchenne smiles and symmetrical non-Duchenne smiles. After each smile, participants were required to judge if the person was really happy or not. Results from this study showed that the symmetrical and asymmetrical Duchenne smiles were viewed as being happier than the symmetrical non-Duchenne smiles. The absence of differences between the symmetrical Duchenne smiles and asymmetrical Duchenne smiles, however, implied that there might be some difficulty in attending to the differences in symmetry or that the differences in symmetry might be too small to be detected by the participants. Although adult participants performed above chance level in the judgment of smile authenticity of Duchenne and non-Duchenne smiles, they reported perceiving the Duchenne smiles as being really happy only around half of the time. This conservative level of success in the smile judgment task further supported the possibility that results could be due to limitations in perceptual-attentional processing. Although it is possible that the finding could be explained by the difficulty attending to the features, it is unclear if the participants were unable to detect the differences or if they did not perceive the Duchenne marker or symmetry as cues that reflected genuine smiles.

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In another study by Chartrand and Gosselin (2005), participants viewed videoclips of people exhibiting symmetrical Duchenne smiles, asymmetrical Duchenne smiles and symmetrical non-Duchenne smiles in the first half of the study. For every smile that was presented, participants were required to rate the level of happiness. In the second half of the study, participants were split into two conditions, whereby those in one condition were presented with information about facial changes associated with the Duchenne marker and the Lip Corner Puller before they began the task, while those in the other condition were not presented with these information. Participants were then presented with pairs of smiles and their task was to judge if each pair of smiles were the same or different from each other. Consistent with the finding from Gosselin et al.'s (2002) study, the symmetrical Duchenne smiles were being perceived as being happier than the symmetrical non-Duchenne smiles. The asymmetrical smiles in this study, on the other hand, were being perceived as less happy than the symmetrical non-Duchenne smiles. For the difference-detection task, it was found that participants were able to discriminate between the different types of smiles and were better at the detection of symmetrical differences than detection of the Duchenne marker. However, participants perceived more paired smiles as being similar to each other even though the number of paired smiles that were similar and the number of paired smiles that were different were the same. In other words, participants had a tendency to underestimate the difference between smiles when a difference was present between a pair of smiles, suggesting the possibility that participants might have some difficulties in the perception of the morphological cues. Although this finding could be explained by the perceptual-attentional hypothesis, the mediation analysis showed that the ability in the judgment of smile happiness was not related to participants' ability in the discrimination of smiles. Therefore, the researchers suggested that participants' ability in the judgment of smile authenticity might be better explained by factors other than the perceptual-attentional factors. Nonetheless, the

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detection of markers was not measured during the smile judgment task, which implied the possibility that participants might fail to detect the markers when their task was to judge the authenticity of smiles. Therefore, the perceptual-attentional hypothesis cannot be rejected based solely on this finding.

In order to test the perceptual-attentional hypothesis, Manera et al. (2011) conducted a study focusing on eye movements during the smile judgment task. Participants' eye movements were recorded during the smile judgment task to examine if perceptual or attentional difficulties were present and if they could explain participants' smile judgment performances. In the smile judgment task, participants were presented with symmetrical Duchenne smiles and symmetrical non-Duchenne smiles. Unlike previous studies (Gosselin et al., 2002; Chartrand & Gosselin, 2005), the non-Duchenne smiles in this study included not only smiles with neutral eyes, but also smiles with the activation of the Lid Tightener. The activation of the Lid Tightener is similar to the Duchenne marker as they both lead to the narrowing of eyes but unlike the Duchenne marker, the activation of the Lid Tightener does not raise the cheek nor does it lead to wrinkles at the corners of the eyes (Del Giudice & Colle, 2007). Participants had to judge if each smiling face was truly happy or not. Results from the judgment task revealed that participants responded correctly around 70% of the time. Further analysis showed that participants spent a larger proportion of time looking at the eye regions for the Duchenne smiles and the non-Duchenne smiles where the Lid Tightener was activated than when looking at non-Duchenne smiles with neutral eyes. This suggested that participants were able to detect the presence of muscle activation in the eye regions. Correlation analysis from the study showed that no correlation was observed between the individual performance in the smile judgment task and eye movement measures. This raised doubts regarding the use of the perceptual-attentional hypothesis to explain the ability in the judgment of smile authenticity. In spite of this, Perron and Roy-Charland (2013)

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pointed out that performance in the smile judgment task was not analysed separately for the Duchenne smiles and the two non-Duchenne smiles. While results do not support the perceptual-attentional hypothesis, it was unclear if performance differed in the authenticity judgment of Duchenne and non-Duchenne smiles. Therefore, clear interpretation of the results was not possible and further investigation was required.

Similarly, a recent study by Perron and Roy-Charland (2013) examined the perceptual-attentional hypothesis by recording participants' eye movements while they performed a smile judgment task. In the study, pictures of faces that exhibited symmetrical Duchenne smiles, asymmetrical Duchenne smiles and symmetrical non-Duchenne smiles were presented. When each picture was presented, participants had to determine if the person in the picture was really happy or not. Results showed that out of the three types of smiles, the symmetrical Duchenne smiles were most likely to be perceived as being really happy. It was also found that when compared to the symmetrical non-Duchenne smiles, the asymmetrical Duchenne smiles were more likely to be perceived as reflecting genuine happiness. The fact that participants in the study performed equally well at judging the symmetrical Duchenne smiles as really happy and the symmetrical non-Duchenne smiles as not really happy suggested that there were no difficulties in the perception or interpretation of the Duchenne marker as a sign of smile authenticity. Participants were expected to spend a longer time viewing the eye region if the presence of the Duchenne marker was perceptually processed. However, the eye movement analysis revealed no differences in the time spent looking at the eye region or mouth region for any of the smiles. This supports the notion that participants were sensitive to the Duchenne marker and their smile judgment performance could not be explained by perceptual factors. The study also found that participants made more saccades from one side of the face to the other when viewing the asymmetrical Duchenne smiles than the other two types of smiles. This showed that asymmetrical smiles

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were processed differently from symmetrical smiles, implying that participants were sensitive to the difference between both types of smiles. This suggested that difficulties associated with the authenticity judgment of asymmetrical smiles were unlikely to be due to perceptual or attentional factors. Moreover, the number of saccades made was not linked to participants' performance in the smile judgment task, which raised further doubts on the use of the perceptual-attentional hypothesis to explain difficulties in the judgment of smile authenticity. Results from the eye movement analysis did not appear to support the perceptual-attentional hypothesis but suggested that difficulties in the judgment of smile authenticity could be linked to the interpretation of the morphological cues.

Since results from the studies seemed to suggest that difficulties in the smile judgment task could be associated with the interpretation of facial cues, one of the ways to test the hypothesis is by examining one's explicit knowledge about the morphological cues. However, few studies have explored participants' explicit knowledge or interpretation difficulties in the smile judgment task. In the study carried out by Gosselin and colleagues (2002), participants were given a free response question where they were required to verbally state the facial differences between people who were really happy and those who were pretending to be happy after they viewed the videoclips of all the faces. It was found that more than half of the adult participants provided responses that indicated differences in the Duchenne marker, implying that the participants had some explicit knowledge about the Duchenne marker. On the other hand, only one participant's response indicated differences related to symmetry, which could indicate that knowledge about asymmetry is limited. However, the free response question was asked at the end of the smile judgment task, which poses two limitations to the study. Firstly, it was completed post hoc and not during the judgment task. Therefore, the reported differences were not necessarily used during the judgment task. Secondly, this task only provided information about the knowledge of the

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cues that distinguished really happy and not really happy smiles but not if they were, in fact, interpreted as signs of non-authenticity. Similarly, explicit knowledge about the morphological cues was briefly explored at the end of the difference detection task in the study by Chartrand and Gosselin (2005). Results from Chartrand and Gosselin's (2005) study showed that participants indicated noticing differences in the eye and mouth regions, as well as asymmetry, between the smiles that were presented (symmetrical Duchenne, non-Duchenne and asymmetrical smiles) at least half of the time. Nonetheless, clear conclusions cannot be made regarding the interpretation of the morphological markers based on the results derived from these studies because participants' responses were dependent on their explicit memory and did not necessarily correspond with where they were looking or if the information was interpreted as a sign of authenticity or non-authenticity (Perron & Roy-Charland, 2013).

By using eye movement recording during the smile judgment task and presenting questions that are intended to explore the explicit knowledge of the Duchenne marker and symmetry following the presentation of each stimulus, the present study aimed to address the limitations of previous studies in order to establish a better understanding of the explicit knowledge regarding the morphological cues which might shed some light on their role in smile judgment. In addition, Likert scales instead of dichotomous questions were used for the smile judgment tasks to obtain a better idea of participants' perceived level of happiness and authenticity of the smiling faces, seeing as happiness and authenticity can exist in varying degrees. The use of Likert scales might also provide information about the possible influence of response options on smile judgment tasks.

Studies have shown that differences in instructions could influence the strategies individuals employ to carry out a task (Carlson & Tassone, 1967; Wells, 1993), which could lead to differences in response time (Dickinson & Szeligo, 2008). In addition, Petersson,

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Sandblom, Elfgrén and Ingvar (2003) found that the use of differing instructions could lead to activations in different parts of the brain. Seeing as differences in the wording of instructions could potentially tap into different areas of processing and might contribute to inconsistencies in smile judgment studies, both the judgment of happiness and that of smile authenticity were explored in the present study to examine the possible impact of wording on smile judgment performance, which could imply the role of smile interpretation in smile judgment tasks.

According to previous research, it was predicted that the symmetrical Duchenne smiles would be judged as being more happy most of the time while symmetrical non-Duchenne smiles would be judged as being less happy most of the time. Since previous studies have shown varying findings in regards to the asymmetrical Duchenne smiles, this type of smile could be judged to reflect happiness to the same degree as the symmetrical Duchenne smiles (Gosselin et al., 2002); reflect happiness to a lesser extent than the symmetrical non-Duchenne smiles (Chartrand & Gosselin, 2005); or reflect happiness to a lesser extent than the symmetrical Duchenne smiles (Perron & Roy-Charland, 2013). Based on the findings from Perron and Roy-Charland (2013), it was predicted that in terms of eye movement measures, the total time spent looking at the asymmetrical Duchenne smiles would be longer than the total time spent looking at the other two types of smile. Also, it was expected that participants would make more saccades while viewing asymmetrical than symmetrical smiles. In regards to explicit knowledge, it was predicted that participants would report noticing more cues in the regions that contain smile judgment cues (Gosselin et al., 2002) while participants would detect symmetrical differences that are present more than half of the time (Chartrand & Gosselin, 2005). The relation between happiness and authenticity judgments, however, remains to be examined.

## Method

### Participants

Thirty-two undergraduate students ( $M_{\text{age}} = 21.66$  years; 26 females; 6 males) from Laurentian University participated in the study. All participants reported normal or corrected-to-normal vision and gave informed consent to participate in the study.

### Materials

**Stimuli.** Pictures of smiling faces, taken from Perron and Roy-Charland (2013), were used in this study. The pictures were produced based on the Facial Action Coding System (FACS), which is a system used to describe facial expressions in terms of facial movements and codes 44 facial action units (Ekman et al., 2002). The facial expressions were produced in a lab by two Caucasian females and two Caucasian males and were overseen by a FACS coder. The pictures were then evaluated by two FACS coders and only those with an inter-rater agreement of 100% were included in the study. The pictures consisted of three types of smiles: symmetrical Duchenne, asymmetrical Duchenne, and symmetrical non-Duchenne. Both the symmetrical and asymmetrical Duchenne smiles involved the simultaneous activation of the Cheek Raiser or Action Unit 6 (AU6) and the Lip Corner Puller or Action Unit 12 (AU12) but for the latter, the intensity of the AU6 and AU12 activation for the right side of the face was different from that of the left side of the face. As for the symmetrical non-Duchenne smile, only AU12 was activated to the same degree on each side of the face. The AU6 and AU12 for the symmetrical Duchenne and non-Duchenne smiles were activated at the intensity level of ‘D’ according to the FACS (Ekman, Friesan, & Hager, 2002), in which the intensity of facial muscle activation ranges from ‘A’, which represents the minimum intensity, to ‘E’, which represents the maximum intensity. For the asymmetrical Duchenne smiles, the intensity on one side of the face is ‘C’ and ‘D’ on the other side. Examples of stimuli are shown in *Figure 1*. Within each block of trials, the symmetrical

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Duchenne smile from each encoder was shown eight times so a total of 32 symmetrical Duchenne smiles were shown whereas the symmetrical non-Duchenne smile from each encoder was shown four times so a total of 16 non-Duchenne smiles were shown and 16 pictures with asymmetrical Duchenne smiles were presented: 8 with stronger AU6 and 12 activation on the left side of the face and 8 with stronger AU6 and 12 activation on the right side of the face. For each of the asymmetrical smile condition, the smile from each encoder was presented twice. A total of 64 stimuli were used in each block of the study.

**Apparatus.** The EyeLink 1000 was used to track and record eye movements as it has a high accuracy level of  $0.25^\circ$  to  $0.5^\circ$  and a high sampling rate of 2000 Hz. The device, which was made up of a camera and an infrared illuminator, was placed below the computer screen that was in front of the participant. Calibrations<sup>1</sup> were carried out for participants' eyes and they were considered successful if the calibration errors were less than one degree in visual angle. Similar to previous studies that used eye-tracking devices in smile judgment tasks (Manera et al., 2011; Perron & Roy-Charland, 2013), one eye was tracked. In the current study, the right eye was the default eye tracked. The EyeLink 1000 transfers recorded real-time eye movement data to a computer using an Ethernet connection. One computer was used for the presentation of stimuli while another was used by the experimenter for viewing participants' gaze position in real-time.

### Procedure

The experiment was conducted in a room in which each participant was tested individually by an experimenter. Prior to the experiment, participants were informed that pictures of smiling faces, with the pictures being presented one at a time, would be shown

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<sup>1</sup>A 9-dot calibration method was used for the calibration of eyes and participants were asked to fixate on the dot that appeared on the screen. The procedure began by the presentation of a dot, which then disappeared before appearing in a different location on the screen. The dot appeared in 9 locations and this procedure was carried out twice. The EyeLink 1000 system then verifies if participants' eyes were close enough to the target position.

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and their task was to answer a series of questions regarding these pictures. They were informed that the questions would be provided orally by the experimenter. Participants were asked to position their head on the chin and head rest to allow for the recording of their eye movements. There were 2 blocks of trials and each block was made up of 64 stimuli. In the first block of trials, participants were first required to judge the level of happiness of the smiles and provide their responses based on a 7-point Likert scale (where 0 meant “the person is not happy at all” and 6 meant “the person is totally happy”). When the decision was made, participants pressed the mouse button and a blank screen appeared. They were then required to respond verbally while the experimenter took note of their responses. After that, the smile was represented and participants were required to judge the smile authenticity on a 7-point Likert scale (where 0 meant “the person’s smile is not authentic at all” and 6 meant “the person’s smile is totally authentic”). Participants pressed the mouse button when they made their decision. Next, a blank screen appeared and the experimenter noted the participants’ verbal responses. Throughout the trial, the word “happiness” or “authenticity” was verbalized by the experimenter before each picture was presented in order to ensure that the participants knew what they were judging. The happiness and authenticity judgment tasks were counterbalanced.

Participants were then presented with the second block of trials, where each trial contained a series of questions pertaining to happiness and a series of questions pertaining to authenticity. First, a smile was presented and participants were required to answer on the 7-point Likert scale pertaining to happiness. Participants pressed the mouse button when they have made their decision and a blank screen appeared. They would then provide a verbal response. Second, the experimenter asked “Did you notice cues in the mouth/ nose/ eyes/ chin/ cheeks/ forehead?” and the smile was represented. The smiles stayed on the screen when each zone was being enquired and the order of the zones was counterbalanced in the

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task. Participants were again required to provide their responses verbally while the experimenter took note of their responses. When participants had responded, they pressed the mouse button and a blank screen appeared. Third, the experimenter asked “Did you notice symmetrical differences in the face?” and the smile was represented again. Parts 2 and 3 were counterbalanced within the task. The second series of questions pertained to the level of authenticity of the smiles. Participants were required to answer on the 7-point Likert scale pertaining to authenticity. Parts 2 to 3 were exactly the same as for the first series and the two series were also counterbalanced.

### **Data analyses**

The alpha level of .05 was used for all statistical tests unless otherwise indicated and the Greenhouse-Geisser correction was used when sphericity was violated. The perceived happiness and authenticity levels were measured by 7-point Likert scales and the mean levels of perceived happiness and authenticity were computed for each type of smile (symmetrical Duchenne, non-Duchenne and asymmetrical) presented in the first block of trials. All of the stimuli presented in the current study composed of posed smiles that contained the characteristics of enjoyment and non-enjoyment smiles. Hence, in the context of this study, authenticity did not refer to whether a smile was posed or not but referred to the extent to which a smile reflected an enjoyment smile.

The eye movement data from the first block of trials were analysed. The EyeLink Dataviewer, which is a program that reveals participants’ fixations when a stimulus is being presented on the computer screen, was used to code the eye movement data. The total viewing time for each stimulus, which took into account participants’ fixation on the stimulus from the moment it appeared on the computer screen until it disappeared from the screen, was derived from the program. The amount of time (dwell time) spent viewing the eye and mouth regions was also recorded. Since the total time a stimulus was presented was

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controlled by the participant, the proportion of time spent looking at each region of interest was also used to control for differences in total viewing time. The proportion of time spent looking at the eye and mouth regions were computed by dividing the amount of time spent looking at each facial region by the total amount of time spent looking at the stimulus. In addition, the number of saccades was recorded. An eye movement is counted as a saccade every time participants' eyes travel from one side of the face to the other, crossing the middle of the stimulus (see Perron & Roy-Charland, 2013).

For the explicit knowledge questions, the number of "Yes" responses was calculated for each facial region (mouth, nose, eyes, chin, cheeks and forehead). The proportion of "Yes" responses was calculated for each region by dividing the number of "Yes" responses in that region by the total number of trials in the second block of trials. Since the eyes, mouth and cheek regions contain cues for smile judgment while the nose, chin and forehead do not, an analysis was carried out for the regions containing smile judgment cues and a separate analysis was carried out for the regions that do not contain smile judgment cues. A variation in intensity was present for the asymmetrical smile but not for the symmetrical Duchenne and non-Duchenne smiles. In order to examine if participants were aware of the intensity differences while judging smiles, the number of "Yes" responses to the explicit knowledge question pertaining asymmetry was recorded for each stimulus. For each smile type, the proportion of "Yes" responses was calculated by dividing the number of "Yes" responses by the total number of trials that involved that particular smile type.

## Results

### Basic effects of smile judgment

**Answering "really happy" or "really authentic".** Results for happiness and authenticity judgments are presented in *Table 1*. A 2 x 3 repeated-measures ANOVA with

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question type (happiness and authenticity) and smile type (symmetrical Duchenne, non-Duchenne and asymmetrical) revealed a main effect of smile type,  $F(1.258, 39.009) = 80.64$ ,  $p < .001$ ,  $\eta_p^2 = .72$ , and a significant interaction,  $F(1.387, 42.987) = 5.95$ ,  $p = .011$ ,  $\eta_p^2 = .16$ , but the main effect of question type (happiness and authenticity) was not significant,  $F < 1$ . For simple main effect tests, Dunn's correction was applied to the alpha levels. Thus, to be considered significant, a  $p$  value had to be smaller than .03. Simple main effect tests showed that the symmetrical Duchenne smiles were judged as being more happy than authentic,  $F(1, 93) = 6.32$ ,  $p = .014$ ,  $\eta_p^2 = .06$ , that the asymmetrical smiles were judged as being more authentic than happy,  $F(1, 93) = 6.19$ ,  $p = .015$ ,  $\eta_p^2 = .06$ , but there was no effect of the question type for the non-Duchenne smiles,  $F < 1$ . Furthermore, for both type of questions, results revealed differences between the types of smiles, authenticity:  $F(2, 124) = 104.39$ ,  $p < .001$ ,  $\eta_p^2 = .63$ , happiness:  $F(2, 124) = 140.64$ ,  $p < .001$ ,  $\eta_p^2 = .69$ . Post hoc tests (LSD) revealed that for both types of questions, the means were higher for the symmetrical Duchenne smiles than the non-Duchenne smiles and higher for the non-Duchenne smiles than for the asymmetrical smiles.

### Eye movement measures

**Total viewing time.** A 2 x 3 repeated-measures ANOVA with question type (happiness and authenticity) and smile type (symmetrical Duchenne, non-Duchenne and asymmetrical) showed a significant interaction (*Table 2*),  $F(2, 62) = 5.52$ ,  $p = .006$ ,  $\eta_p^2 = .15$ , but neither the main effect of question type,  $F < 1$ , nor the main effect of smile type,  $F < 1$ , was significant. Again, Dunn's correction was applied to the alpha levels ( $\alpha = .03$ ) for simple main effect tests. Simple main effect tests showed that there were no significant differences between smiles for happiness question,  $F(2, 124) = 2.35$ ,  $p = .10$ , or for

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authenticity question,  $F < 1$ .<sup>2</sup> Also, there were no differences between question type for the symmetrical Duchenne smiles,  $F < 1$ , non-Duchenne smiles,  $F(1, 93) = 1.47, p = .23$ , or asymmetrical smiles,  $F < 1$ .

**Time spent viewing facial regions of interest.** For dwell time (time spent in the eye and mouth regions), a  $2 \times 2 \times 3$  repeated-measures ANOVA with question type (happiness and authenticity), facial zone (eyes and mouth) and smile type (symmetrical Duchenne, non-Duchenne and asymmetrical) did not reveal any significant main effects (all  $F$ s  $< 1$ ). The interaction between question type and facial zone,  $F(1, 31) = 1.80, p = .19$ , between question type and smile type,  $F < 1$ , and between facial zone and smile type,  $F < 1$ , were not significant. Similarly, the interaction between the three factors was not significant,  $F < 1$ .

For the proportion of time spent viewing the facial regions of interest (see *Table 3*), a  $2 \times 2 \times 3$  repeated-measures ANOVA with question type (happiness and authenticity), facial zone (eyes and mouth) and smile type (symmetrical Duchenne, non-Duchenne and asymmetrical) revealed a significant main effect of smile type,  $F(1.568, 48.608) = 5.12, p = .015, \eta_p^2 = .14$ , but the main effects of question type,  $F(1, 31) = 2.52, p = .12$ , and facial zone,  $F < 1$ , were not significant. None of the interactions were significant: the interaction between question type and facial zone; the interaction between question type and smile type; the interaction between facial zone and smile type; and the interaction between question type, facial zone and smile type (all  $F$ s  $< 1.72$ ). Post hoc tests (LSD) showed that the proportion of time spent viewing the interest regions were larger for the symmetrical Duchenne smiles ( $M = .26, SD = .06$ ) than the non-Duchenne smiles ( $M = .25, SD = .08$ ) and the asymmetrical

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<sup>2</sup> Judging from the  $p$  values that were obtained for the simple main effect tests, the interaction might have been driven by the differences between smiles for happiness questions because the  $p$  value was closest to being significant ( $p = .10$ ). However, the differences between smiles for happiness questions would not be discussed because the exact reason driving the interaction could not be determined from this study.

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smiles ( $M = .25$ ,  $SD = .07$ ) while there were no significant differences between the non-Duchenne smiles and the asymmetrical smiles.

**Saccades between the sides of the face.** A 2 x 3 repeated-measures ANOVA with question type (happiness and authenticity) and smile type (happiness and authenticity) did not show a significant main effect of question type,  $F < 1$ , or smile type,  $F(1.550, 48.035) = 1.31$ ,  $p = .27$ . The interaction was also not significant,  $F(2, 62) = 1.52$ ,  $p = .23$ .

### Explicit knowledge questions

**Responses to “Did you notice cues in the mouth/ nose/ eyes/ chin/ cheeks/ forehead?”** The proportion of cues noticed in the eyes, mouth and cheeks are shown in *Table 4*. A 2 x 3 x 3 repeated-measures ANOVA with question type (happiness and authenticity), smile type (symmetrical Duchenne, non-Duchenne and asymmetrical) and facial region (eyes, mouth and cheeks) revealed a main effect of smile type,  $F(1.169, 36.252) = 9.53$ ,  $p = .003$ ,  $\eta_p^2 = .24$ , and facial region,  $F(1.387, 42,994) = 13.32$ ,  $p < .001$ ,  $\eta_p^2 = .30$ . There was also a significant interaction between smile type and facial region (see *Table 5*),  $F(2.356, 73.021) = 3.71$ ,  $p = .023$ ,  $\eta_p^2 = .11$ . On the other hand, the main effect of question type was not significant,  $F(1, 31) = 1.12$ ,  $p = .30$ . No significant interactions were found between question type and smile type,  $F(2, 62) = 1.90$ ,  $p = .16$ , between question type and facial region,  $F < 1$ , or between question type, smile type and facial region,  $F(3.152, 97.697) = 1.47$ ,  $p = .23$ . For simple main effect tests, Dunn’s correction was applied to the alpha levels. Therefore, a  $p$  value had to be smaller than .025 to be considered significant. Simple main effect tests showed that the proportion of cues participants reported being aware of in the cheeks differed between the types of smiles,  $F(2, 186) = 7.36$ ,  $p < .001$ ,  $\eta_p^2 = .07$ , but smile type had no significant effects on the eye,  $F(2, 186) = 2.62$ ,  $p = .08$  or mouth regions,  $F < 1$ . Results also showed differences in the proportion of noticed cues between the facial regions for the non-Duchenne smiles,  $F(2, 186) = 9.52$ ,  $p < .001$ ,  $\eta_p^2 = .09$ , and for the asymmetrical

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smiles,  $F(2, 186) = 3.86, p = .023, \eta_p^2 = .04$ , but not for the symmetrical Duchenne smiles,  $F(2, 186) = 3.27, p = .04$ . Post-hoc tests (LSD) revealed that the proportion of noticed cues in the cheeks was larger for the symmetrical Duchenne smiles and asymmetrical smiles than the non-Duchenne smiles but there were no differences between the symmetrical Duchenne smiles and asymmetrical smiles. It was also found that for non-Duchenne smiles, the proportion of noticed cues in both the eye and mouth regions were larger than that in the cheek region. For asymmetrical smiles, the proportion of noticed cues in the eye region was larger than that in the mouth region, which, in turn, was larger than that in the cheek region.

The proportion of cues noticed in the nose, chin and forehead are shown in *Table 6*. A  $2 \times 3 \times 3$  repeated-measures ANOVA with question type (happiness and authenticity), smile type (symmetrical Duchenne, non-Duchenne and asymmetrical) and facial region (nose, chin and forehead) showed significant main effects of smile type,  $F(1.465, 45.420) = 6.21, p = .008, \eta_p^2 = .17$ , and facial region,  $F(2, 62) = 7.23, p = .001, \eta_p^2 = .19$ . Inspection revealed a significant interaction between question type and facial region (see *Table 7*),  $F(2, 62) = 3.34, p = .042, \eta_p^2 = .10$ , and between smile type and facial region (see *Table 8*),  $F(2.447, 75.864) = 5.06, p = .005, \eta_p^2 = .14$ . The main effect of question type was not significant,  $F < 1$ . Neither the interaction between the main effects of question type and smile type,  $F(1.689, 52.369) = 1.49, p = .24$ , nor the interaction between the main effects of question type, smile type and facial region,  $F(4, 124) = 1.20, p = .31$ , was significant. Simple main effect tests with Dunn's correction ( $\alpha = .03$ ) showed that there were no significant differences in the proportion of noticed cues between the three facial regions for happiness questions,  $F(2, 124) = 2.85, p = .06$ , or authenticity judgments,  $F(2, 124) = 1.87, p = .16$ .<sup>3</sup> Also, no

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<sup>3</sup> When analyses were performed with all the facial regions together (cheeks, eyes, mouth, nose, chin and forehead), the interaction between question type and facial region was not significant,  $F(3.196, 99.075) = 1.40, p = .25$ . It is possible that the simple main effect tests

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significant differences were found between question type for nose, chin or forehead regions (all  $F$ s  $< 1$ ). Simple main effect tests with Dunn's correction ( $\alpha = .025$ ) showed that for the symmetrical Duchenne smiles, there were significant differences in the proportion of noticed cues between the facial regions,  $F(2, 186) = 5.96, p = .003, \eta_p^2 = .06$ . However, no significant differences were observed for the non-Duchenne smiles,  $F(2, 186) = 1.49, p = .23$ , or the asymmetrical smiles,  $F(2, 186) = 3.08, p = .05$ . In addition, results showed that there were differences in the proportion of noticed cues between the types of smiles for the chin region,  $F(2, 186) = 7.42, p < .001, \eta_p^2 = .07$ , but no differences were found for the nose or forehead regions (both  $F$ s  $< 1$ ). Further inspection with post-hoc tests (LSD) revealed that for symmetrical Duchenne smiles, the proportion of cues noticed in the chin region was larger than that in the nose and forehead region respectively. Post-hoc tests also revealed that the proportion of cues in the chin that were noticed by participants was larger for the symmetrical Duchenne smiles than the asymmetrical smiles and larger for the asymmetrical smiles than the non-Duchenne smiles.

**Responses to “Did you notice symmetrical differences in the face?”** The proportion of symmetrical differences that were noticed for each type of smile for the happiness and authenticity questions are presented in *Table 9*. A  $2 \times 3$  repeated measures ANOVA with question type (happiness and authenticity) and smile type (symmetrical Duchenne, non-Duchenne and asymmetrical) revealed a significant main effect of smile type,  $F(2, 62) = 51.87, p < .001, \eta_p^2 = .63$ , but the main effect of question type was not significant,  $F(1, 31) = 11.27, p = .27$ . Similarly, the interaction was not significant,  $F(2, 62) = 1.58, p = .22$ . Further analysis using post hoc tests (LSD) showed that the proportion of “Yes” responses were significantly larger for the asymmetrical smiles than either the symmetrical

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were not significant due to the barely significant interaction between question type and facial region ( $p = .042$ ).

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Duchenne smiles or the non-Duchenne smiles while there were no differences between the symmetrical Duchenne smiles and the non-Duchenne smiles.

### **Discussion**

Perceptual-attentional difficulties have been put forward as an explanation for the difficulties in judging the authenticity of smiles (Boraston et al., 2008). However, several recent studies have suggested that the difficulties might instead be associated with the interpretation of cues of authenticity or non-authenticity because of the failure to find a link between eye movement data and smile judgment performance (Manera et al., 2011; Perron & Roy-Charland, 2013) or between participants' discrimination ability and their smile judgment performance (Chartrand & Gosselin, 2005). Therefore, the aim of this study was to examine the explicit knowledge of the Duchenne marker and symmetry in the judgment of happiness and authenticity of smiles, which are both morphological features that have been proposed to differ between an enjoyment smile and a non-enjoyment smile (Ekman et al., 1981, 1990). The explicit knowledge of morphological cues was examined by asking participants to report if they noticed facial cues in certain regions while making happiness and smile authenticity judgments. Furthermore, the current study also examined the role of response options in the judgment task. More precisely, a Likert scale, instead of close-ended questions, was employed to allow for a wider range of variability on the extent of an individual's perceived degree of happiness and authenticity of smiles as well as the impact of the response strategies based on the options.

### **Responses in the judgment tasks**

For the smile judgment tasks, the symmetrical Duchenne smiles were viewed as being the happiest and most authentic out of the three types of smiles. This is not surprising given that most research has shown that symmetrical Duchenne smiles were judged as being more

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genuine than non-Duchenne smiles (Calvo et al., 2013; Gosselin et al., 2002; Perron & Roy-Charland, 2013; Thibault et al., 2009). In effect, the results of this study appear to support the idea that individuals are able to differentiate the symmetrical Duchenne smiles from the non-Duchenne smiles and the asymmetrical smiles. Furthermore, the Duchenne marker appears to be interpreted as a sign of happiness and smile authenticity. Since results also showed that the symmetrical Duchenne smiles were viewed as being more happy and authentic than the asymmetrical smiles, this also implies that symmetry might be perceived and interpreted as a cue of happiness and smile authenticity.

The non-Duchenne smiles were viewed as being more happy and authentic than the asymmetrical smiles but less happy and authentic than the symmetrical Duchenne smiles. As for the asymmetrical smiles, they were viewed as being the least happy and authentic out of the three smile types. These findings were consistent with the previous study by Chartrand and Gosselin's (2005), which showed that the non-Duchenne smiles were judged as being happier than the asymmetrical smiles but less happy than the symmetrical Duchenne smiles. On the other hand, the results from this study did not support the findings in other studies that found that the asymmetrical smiles were perceived as being equally happy as the symmetrical Duchenne smiles (Gosselin et al., 2002) or that the asymmetrical smiles were seen as being more happy than non-Duchenne smiles (Perron & Roy-Charland, 2013). Seeing as the Likert scale was used in the current study and in the study by Chartrand and Gosselin (2005), the similarity in findings might be attributable to the use of the Likert scale in the two studies. In other words, participants' smile judgment performance might be influenced by the way in which they were required to respond, which seems to reflect an indirect support of the role of smile interpretation to a higher degree than perceptual-attentional factors.

Interestingly, the present study also found that the symmetrical Duchenne smiles were being judged as being more happy than authentic while the asymmetrical smiles were being

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judged as being more authentic than happy, implying that participants' interpretation of the question plays a part in smile judgment as well. Considering studies that have found that the use of different wording in instructions could lead to different outcomes, including differences in causal judgments (White, 2003), size judgments (Carlson & Tassone, 1967) and response time (Dickinson & Szeligo, 2008), the findings further stresses the importance of smile interpretation in smile judgment tasks. However, the symmetrical Duchenne smiles were still judged as being the happiest and most authentic out of the three types of smiles while the asymmetrical smiles were rated as being the least happy and authentic. In other words, despite the influence of the words used in the question on smile judgments, there were no effects in the differentiation between types of smiles.

The results in regards to the use of different question type (authenticity vs. happiness) and answer options (scale vs. yes/no) have important implications for this field of research. Seeing as the impact of question type was not strong enough to override the effect of the smile differences used in this study, this could be useful from the research point of view in that it could imply that inconsistencies in smile judgment studies are unlikely to be due to small differences in the words chosen to frame the questions. Nonetheless, the results reflected the importance in the interpretation of questions.

Considering the words "authenticity" and "happiness" pose different meanings, it is not surprising that smile authenticity would be interpreted differently from happiness. Following this, judgments of the "genuineness" of smiles might be more likely to elicit similar outcomes as judgments on the "authenticity" of smiles than judgments on "happiness" since the former two share the same meaning. Since participants were asked to provide happiness and authenticity judgments one after the next for each stimulus that was presented in the first block of trials, participants who were asked to provide happiness judgments prior to authenticity judgments would be likely to remember the happiness score they gave when

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asked to make authenticity judgments, and vice-versa. Hence, it is possible that some participants might have given slightly different ratings for the two judgment conditions because they thought that they were expected to distinguish between “happiness” and “authenticity” ratings. For instance, the symmetrical Duchenne smiles might be more readily associated with happiness, thus some participants might have adjusted their authenticity scores according to the happiness scores they provided by giving slightly lower ratings for authenticity (or adjusted their happiness scores according to the authenticity scores they provided by giving slightly higher happiness scores). On the other hand, asymmetrical smiles might be more readily associated with lower levels of happiness so participants might have provided slightly higher authenticity scores to try and differentiate between happiness and authenticity judgments. In order to explore if this was the rationale behind the reason different ratings were allocated to happiness and authenticity judgments, it might be helpful to use a between-subjects design where participants are only required to make one type of judgment (happiness or authenticity) on each occasion to ensure that the scores on one judgment is not dependent on the other. Alternatively, the smile judgment task could be split into two sections so that participants would be asked to make only happiness judgments in one section and authenticity judgments in the other.

The use of different answer options, however, seemed to have a stronger influence on smile judgment because the smile judgment results from the current study were similar to those found in Chartrand and Gosselin’s (2005) study in which participants, like those of the current study, were required to provide their smile judgments based on a Likert scale. This notion was further supported by the differences in findings between the current study and studies in which participants were required to judge if smiles were “really happy” or “not really happy” (Gosselin et al., 2002; Perron & Roy-Charland, 2013). As participants made smile judgments based on static pictures in the study by Perron and Roy-Charland (2013)

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while smile judgments were made based on videoclips in both the study by Chartrand and Gosselin (2005) and Gosselin et al. (2002), the type of stimuli (static pictures vs. videoclips) used in the studies might have appeared to be one of the factors that could have contributed to the differences in findings. However, the results do not explain why the findings differed between the two studies that both used videoclips of smiling faces as their stimuli. Also, this could not explain why the findings differed between the current study and the study by Perron and Roy-Charland (2013) when static pictures were used as stimuli in both studies. In fact, the smile judgment results from the current study should be more similar to those derived from Perron and Roy-Charland's (2013) study seeing as the stimuli used in the current study were taken from Perron and Roy-Charland's (2013) study. Different findings were obtained despite the similarity of the stimuli used in the studies. It is important to note that results from the current study cannot rule out the impact the type of stimuli might have on smile judgments seeing as different results were found in the studies where participants judged each smile as either "really happy" or "not really happy" (Gosselin et al., 2002; Perron & Roy-Charland, 2013) but they implied that response options might explain some of the discrepancies in smile judgment studies. Consequently, future studies should take into consideration the influence of response options on smile judgments.

Furthermore, results from the current study also rejected the notion that individuals have difficulty judging asymmetrical smiles (Perron & Roy-Charland, 2013) since the asymmetrical smiles in the current study were judged as the least happy and authentic out of the three types of smiles. Instead, the mean judgment scores of over three for both happiness and authenticity on the 7-point Likert scales for non-Duchenne smiles suggested that participants might be more inclined to view non-Duchenne smiles as reflecting happiness and authenticity. That being said, it should be noted that the average smile judgment score for the symmetrical Duchenne smiles did not reach '5' on the Likert scale that could range from 0 to

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6. In fact, the average smile judgment scores ranged from between 2 and 5. Therefore, this seemed to indicate that participants did not view the symmetrical Duchenne smiles as being extremely happy and authentic, nor did they view the non-Duchenne and asymmetrical smiles as reflecting extremely low happiness and authenticity. Similarly, the range in the average smile judgment scores was small in Chartrand and Gosselin's (2005) study, ranging from between 2 and 4 on a 0-6 Likert scale. This indicated the possibility that the information derived from static stimuli of posed smiles alone was not sufficient for participants to make clearer judgment differences between enjoyment and non-enjoyment smiles. Nonetheless, the changes in findings with the use of different answer options highlighted the link between smile judgments and the interpretation of smiles and this suggested that smile interpretation might play a stronger role in smile judgments than perceptual-attentional difficulties.

From the theoretical point of view, this not only implied that perceptual-attentional factors, such as the ability to detect the Duchenne marker or asymmetry, alone are insufficient to explain the differences in smile judgment performance, but they are also unlikely to be the major reasons that contributed to smile judgment differences. Seeing as the interpretation of smiles appeared to change with the use of different answer options, this provided an indirect support for the role of smile interpretation in smile judgments and suggested that a stronger emphasis should be put on the role of smile interpretation. In addition, it highlights the need to take into account the instruments used to measure smile judgments as it is possible that different response options would encourage different forms of processing or response strategies. It could be that participants had more explicit knowledge regarding the Duchenne marker and this encouraged individuals to judge non-Duchenne smiles as being "not really happy" when faced with two choices ("really happy" or "not really happy"). On the other hand, although participants might perceive the asymmetrical smiles as being less happy and authentic than the symmetrical Duchenne and non-Duchenne

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smiles, the lack of explicit knowledge regarding asymmetry might lead to lower levels of confidence and higher levels of indecisiveness when forced to make a decision between the two choices for asymmetrical smiles. In other words, direct exploration of the explicit knowledge regarding the Duchenne marker and asymmetry is necessary to improve our understanding in smile judgments because the smile judgment results only provided an indirect indication for the influence of smile interpretation. Results pertaining to this question are discussed in a later section.

### **Eye movements in the judgment tasks**

Results from the eye-tracking measures showed that for the total viewing time, question type (happiness and authenticity) had different effects on the three types of smiles such that participants did not consistently spend more time viewing the stimuli when they had to make happiness judgments or when they had to make authenticity judgments. A closer inspection showed that there were no significant differences in the total time participants spent viewing the stimuli between the happiness and authenticity judgment conditions. This suggested that if words that differed in meanings had an influence on the amount of time participants spent viewing the smiles before making smile judgments, the effect is only a minor one. Similarly, participants did not show differences in the total time they spent looking at the different smile types. In other words, the results indicated that participants spent similar amount of time viewing all three types of smiles, regardless of whether they were making happiness or authenticity judgments.

The lack of differences in the total viewing time between the different smile types was inconsistent with the eye movement results derived from the study by Perron and Roy-Charland (2013) that revealed a longer total viewing time for the asymmetrical smiles than the symmetrical Duchenne and non-Duchenne smiles, which the authors suggested was a possible indicator of participants' difficulty in processing asymmetrical smiles. However, this

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absence of differences in the current study seemed to reject the idea that participants had difficulty processing the asymmetrical smiles. Although results showed that participants took the longest time to view the asymmetrical smiles when making happiness judgments and this might appear to lend support to the notion that participants had difficulty judging the asymmetrical smiles, the results were not significant. Also, there were no significant differences in the total viewing time for the authenticity judgments. Furthermore, the non-Duchenne smiles, when compared to the asymmetrical smiles, had happiness and authenticity scores that leaned more towards the end of the Likert scale that represented ‘totally happy’ and ‘totally authentic’ than the end that represented ‘not happy at all’ and ‘not authentic at all’. Following this, if participants had any difficulty in smile judgments, it should be associated with the non-Duchenne smiles and not the asymmetrical smiles. Consequently, a longer total viewing time would be expected for the non-Duchenne smiles in the current study. However, this was not the case. In fact, judging solely from the lack of differences in the total time taken to view the three types of smiles, there were no indicators that participants had problems processing any of the smiles. More importantly, the absence of differences between the results derived from the total viewing time and the smile judgment results seemed to imply that perceptual-attentional factors might only play a minor part, if any, in influencing smile judgments.

It is possible that the differences in findings between the current study and the study by Perron and Roy-Charland (2013) could be attributed to differences in methodology. For example, participants in the current study were required to use Likert scales to provide ratings on the happiness and smile authenticity of each smile while those in Perron and Roy-Charland’s (2013) study were required to judge if each smile was really happy or not really happy. Consequently, the wider range of response options that were available with the use of the Likert scale might have allowed participants in the current study to make their decisions

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with fewer difficulties than those in Perron and Roy-Charland's (2013) study, who had limited flexibility in their choices. When required to choose between only two options, the participants in Perron and Roy-Charland's (2013) study might have had more difficulties placing the asymmetrical smiles at either ends of the spectrum (really happy vs. not really happy) because even though they might perceive the asymmetrical smiles as being less happy, they might have less explicit knowledge about asymmetry as a sign that a person is not really happy. On the other hand, they might have more explicit knowledge that the absence of the Duchenne marker is a sign that a person is not really happy while the presence of the Duchenne marker is a sign that a person is really happy. Seeing as the asymmetrical smiles contained the Duchenne marker, participants might have a difficult time trying to justify why they perceived the asymmetrical smiles as being less happy despite the presence of the Duchenne marker. Hence, they might doubt their initial judgments of the smiles and subsequently spend more time viewing the asymmetrical smiles before responding. However, the average total time participants spent viewing each type of smile appeared to be lower in Perron and Roy-Charland's (2013) study ( $< 3000\text{ms}$ ) than in the current study ( $> 4000\text{ms}$ ). Therefore, it is also possible that participants in Perron and Roy-Charland's (2013) study felt the need to respond quicker when they had to make a choice between two options (really happy vs not really happy) than participants in the current study who had to make smile judgments based on a 0 to 6 scale. Consequently, participants in Perron and Roy-Charland's (2013) study might have been more spontaneous and relied less on conscious processing and thoughts while making the smile judgments, which might then lead to the differences in findings.

In regards to the time spent viewing the eye and mouth regions, participants did not differ in the time they spent viewing these regions, regardless of whether they were making happiness or authenticity judgments. Participants also spent similar amount of time viewing

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the eye and mouth regions for all three types of smiles. This was consistent with the findings from the study by Perron and Roy-Charland (2013), which the authors pointed out provided support against the perceptual-attentional hypothesis seeing as the participants did not differ in the time they spent viewing the eye region regardless of whether the Duchenne marker was present or absent.

Interestingly, participants spent a larger proportion of time looking at the interest regions (eyes and mouth) for the symmetrical Duchenne than the non-Duchenne and asymmetrical smiles. At first glance, this seemed to be inconsistent with the results derived from Perron and Roy-Charland's (2013) study that did not reveal any significant differences in the proportion of time participants spent viewing either the eye or the mouth regions. However, the significant finding in the current study held true only when examining the interest regions as a whole by adding the proportion of viewing time for the eye and mouth regions together. In effect, any significant differences ceased to exist when examining the proportion of time participants spent looking at the eye region on its own or looking at the mouth region on its own, which would be in line with the findings in Perron and Roy-Charland's (2013) study and further questions the suitability of using perceptual-attentional factors to explain smile judgment performance.

In contrast to Perron and Roy-Charland's (2013) study, participants in the current study did not make more saccades when viewing the asymmetrical smiles than the other two types of smiles. In other words, there was no indication that the asymmetrical smiles were being processed in a different way from the symmetrical Duchenne and non-Duchenne smiles. Seeing as the total viewing time for the asymmetrical smiles was significantly longer than that for the symmetrical Duchenne and non-Duchenne smiles in Perron and Roy-Charland's (2013) study, that might be linked to the larger number of saccades made while viewing the asymmetrical smiles in their study. If that were the case, participants in the

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current study would naturally not be expected to make more saccades while viewing the asymmetrical smiles because the total time they spent viewing the asymmetrical smiles was not significantly different from the time they spent viewing the symmetrical Duchenne and non-Duchenne smiles. Following this, it would be interesting to see if participants would still make more saccades while viewing the asymmetrical smiles if an equal amount of viewing time was provided for each stimulus that was presented.

In short, the eye movement results from the current study did not appear to suggest significant difficulties in the processing of any of the smiles or morphological markers used in the current study, nor did it offer support for the perceptual-attentional hypothesis seeing as the eye movement data did not appear to differ between the three types of smiles. This suggests that perceptual-attentional factors are unlikely to explain participants' smile judgment performance and implies that researchers might need to look elsewhere for factors that can better explain smile judgment performance.

### **Explicit knowledge of the morphological cues**

One of the main goals of the current study was to explore explicit knowledge regarding the morphological cues by asking participants to report if they noticed cues in various facial regions when making smile judgments. Results from the explicit knowledge questions might offer some insights into whether smile judgment results could be explained by participants' explicit knowledge of the morphological cues. First, results from the explicit knowledge questions revealed that the average percentage of cues that was reportedly noticed in the eyes, mouth or cheeks, which constitute the actual areas comprising indices of genuineness of the smiles, exceeded 75% for both happiness and authenticity judgments, which could indicate that participants noticed cues in these areas more than half of the time. Judging from the high percentage of cues ( $\geq 90\%$ ) that participants reported noticing in the eye region, the results might imply that participants had some knowledge about the Duchenne marker. This is not

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surprising considering a previous study has shown that more than 80% of the adults in Gosselin et al. (2002)'s study reported that the eyes, mouth and cheek regions differed between individuals who were really happy and those who were pretending to be happy. More importantly, this was not observed only among the adult participants. In fact, Gosselin and colleagues (2002) found that over 75% of the children in their study also responded in the same way, suggesting that even children had some knowledge regarding the Duchenne marker. Nonetheless, it is also possible that the questions that asked participants whether they noticed cues in the different facial regions might have served as a prompt and directed participants' awareness to the facial regions and subsequently led to the high percentage of cues that was reported.

Results indicated that the proportion of cues that participants reported noticing in the eyes and mouth were similar for all three types of smiles while interestingly, they reported noticing a higher percentage of cues in the cheek region when viewing the symmetrical Duchenne and asymmetrical smiles than when viewing the non-Duchenne smiles. If participants only perceived the presence of facial activation as smile judgment cues, the proportion of cues that participants reported noticing in the eye and cheek regions would be expected to be lower for the non-Duchenne smiles than the other two types of smiles seeing as the non-Duchenne smiles do not involve facial changes in the eye and cheek regions. However, the proportion of cues participants noticed in the eye region was not lower for the non-Duchenne smiles despite the lack of activation in the eye region. Therefore, it could be that instead of only perceiving the activation of the eye region as a cue (as seen in the symmetrical Duchenne smiles and asymmetrical smiles), participants also perceived the absence of activation in the eye region or neutral eyes (as seen in the non-Duchenne smiles) as a cue. Following this, if participants regarded both the presence and absence of facial activation as cues, there would be no differences in the proportion of reported cues in the

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cheeks between the Duchenne and non-Duchenne smiles as well. However, the lower proportion of cues noticed in the cheeks for the non-Duchenne smiles indicated the possibility that participants might regard neutral cheeks as being a less important or a less clear smile judgment cue. For example, the absence of activation in the eye region (neutral eyes) might be a more salient cue and thus might override the absence of activation in the cheek region (neutral cheeks) at times.

As for the facial regions that did not differ between the three types of smiles (nose, chin and forehead), the average percentage of cues participants reported in these areas did not exceed 35%. Although this appeared to be lower than the average level of cues that was reportedly noticed for the facial regions that comprised of cues for smile judgment (eyes, mouth and cheeks), it nonetheless meant that participants sometimes reported noticing cues in facial regions that did not differ between the three types of smiles. Therefore, this suggested that whilst participants might have a fairly good explicit knowledge about the morphological cues, this knowledge is not perfect and participants might not be completely aware of the regions they used to make smile judgments. Indeed, the current study is not the first to demonstrate that participants' knowledge of the morphological cues was not completely accurate. For instance, when participants in Gosselin et al.'s (2002) study were asked to indicate facial regions that differ between faces of people who were really happy and people who were pretending to be happy, a portion of participants responded to the question with facial regions that did not differ between the smiles used in the study. However, it is also possible that the presence and absence of the Duchenne marker or asymmetry could cause changes in the appearance of the facial regions that were not considered to differ between the different smile types. For instance, the nose is not considered to provide cues for facial judgments in the current study. However, the symmetrical Duchenne smiles could lead to deep laugh lines that extend from the side of the nose to the mouth (Vick, Waller, Parr, Smith

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Pasqualini & Bard, 2007), which might then lead participants to perceive the nose as being a cue. Alternatively, it is possible that subtle changes were truly present in the nose region and some participants detected the changes and subsequently reported them as being cues used for smile judgment. If this were the case, participants who reported noticing cues in the facial regions that were not considered to contain smile judgment cues in this study might be considered to be more sensitive to subtle facial differences instead of having less than perfect explicit knowledge regarding the morphological cues.

Question type (happiness and authenticity) had different impacts on the proportion of cues reported in the three facial regions (nose, chin and forehead). The proportion of cues participants reported noticing in the nose and chin regions tended to be larger when participants had to judge the happiness of the faces than smile authenticity. Instead of following a similar pattern, the proportion of cues participants reported noticing in the forehead region was larger when participants made authenticity judgments rather than when they made happiness judgments. However, the proportion of cues participants noticed in the nose and chin regions when making happiness judgments was not statistically different from when they were making authenticity judgments. In addition, the proportion of cues participants reported noticing between the three regions was similar regardless of whether they were making happiness or authenticity judgments. Therefore, the results once again suggested that although happiness and authenticity might have different meanings, they did not have a major effect on participants' explicit knowledge regarding the morphological cues.

Results also showed that smile type (symmetrical Duchenne, non-Duchenne and asymmetrical) had different effects on the proportion of cues participants reported noticing in the three facial regions (nose, chin and forehead). Although the proportion of cues participants reportedly noticed in the three facial regions were similar for the non-Duchenne and asymmetrical smiles, the proportion of cues participants reported noticing in the chin was

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larger than those in the nose and forehead for the symmetrical Duchenne smiles. Thus, this indicated that participants might have a slight tendency to perceive the chin as a form of cue when judging the symmetrical Duchenne smiles. This notion was further supported by the finding that when judging the symmetrical Duchenne smiles, the average percentage of cues participants reported noticing in the chin region was above 30% while it was below 20% for the nose and forehead regions. Although the chin region was not considered in this study to be altered by the activation of the Lip Corner Puller that stretched the lips and pulled up the corners of the lips, this alteration in the mouth region might have caused the chin to appear protruded to some individuals. Similar to how the mouth is generally turned upwards in smiles and was viewed as a cue in the smile judgment tasks, this seemingly protruded chin might have been perceived by some as a general characteristic of smiles. However, cues from facial regions that contained indices of happiness and smile authenticity (eyes, mouth and cheeks) might have provided a better cue for lower levels of happiness and authenticity when participants were judging the non-Duchenne and asymmetrical smiles. Thus, this might explain why the proportion of cues noticed in the chin was not large enough to be significantly different from those noticed in the nose and forehead regions for the non-Duchenne and asymmetrical smiles. In addition, the explicit knowledge questions showed that the proportion of cues that participants reported noticing in the chin region for the symmetrical Duchenne smiles was larger than that for the asymmetrical smiles, which, in turn, was larger than that for the non-Duchenne smiles. The reason for this finding is not clear because activation in the mouth is the same for all three types of smiles but again, this could be related to the differing salience of cues for each type of smile.

When participants were asked to indicate if they noticed symmetrical differences in the face, the results showed that participants were more likely to indicate that they noticed symmetrical differences for the asymmetrical smiles than for the symmetrical Duchenne and

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non-Duchenne smiles. Consistent with the findings by Chartrand and Gosselin (2005) and by Gosselin et al. (2010), the results from the current study pointed towards the notion that participants were capable of detecting asymmetry in smiling faces and that the symmetrical differences were not too subtle to be detected. Seeing as the question on symmetrical differences was asked following participants' happiness and authenticity ratings for each stimuli, this suggested that participants noticed asymmetry even when their task was to judge the happiness and authenticity of smiles. However, it should be noted that the average percentage in which symmetrical differences were reported for the asymmetrical smiles was below 70% while the average percentage in which symmetrical differences were reported for the symmetrical Duchenne and the non-Duchenne smiles were above 30%. The difference in the percentage of reported symmetrical differences was not extreme and this once again suggested that although participants might have some explicit knowledge regarding asymmetry, this knowledge was not perfect.

As a whole, results seemed to indicate that participants might not have perfect knowledge regarding the smile judgment cues and their smile judgment performance might be explained by factors other than their explicit knowledge regarding the morphological cues. It is possible that participants relied more strongly on the cues derived from the eyes, mouth and cheeks than cues derived from other facial regions, which therefore allowed them to make smile judgments with few difficulty despite having a less than perfect knowledge regarding the morphological cues.

### **Future directions and limitations**

Seeing as perceptual factors and participants' explicit knowledge regarding the cues did not fully explain participants' smile judgment performance, other factors would need to be taken into account to explain them. For instance, the Simulation of Smile Model has been proposed by Niedenthal, Mermillod, Maringer and Hess (2010) to explain the smile judgment

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performance. According to this model, viewing a facial expression leads to an automatic mimicry of the facial expression, which then causes the observer to experience the observed emotion and subsequently interpret the observed person as experiencing that emotion (Niedenthal et al., 2010). Indeed, Maringer, Krumhuber, Fischer and Niedenthal (2011) found that individuals performed worse in smile judgment tasks when mimicry was prevented, suggesting the possibility that individuals who were better at automatically mimicking facial expressions might be better at smile judgment tasks. However, Manera, Grandi and Colle (2013) also found that unlike individuals who reported having a higher tendency to experience other's emotions for negative emotions, individuals who reported having a higher tendency to experience others' emotions when it came to positive emotions showed poorer performance and tended to perceive the non-Duchenne smiles as "really happy". On this basis, the authors suggested that an individual's ability in emotional and cognitive empathy might influence the individual's smile judgment performance (Manera et al., 2013). If this were true, it could indicate that an individual's smile judgment ability might be partly determined by genetics; a recent study has found that emotional empathy was related to the oxytocin receptor gene while cognitive empathy was related to the arginine vasopressin receptor 1a gene (Uzefovsky et al., 2015). The administration of oxytocin has been shown to improve the ability to determine the emotional state in others (Domes, Heinrichs, Michel, Berger & Herpertz, 2006) and the oxytocin receptor gene has also been linked to autism spectrum disorder (Lerer et al., 2008). Similarly, the arginine vasopressin receptor 1a gene has been associated with autism spectrum disorder (Yang et al., 2010). In addition, the arginine vasopressin receptor 1a gene has been linked to altruistic behaviour (Knafo et al., 2008). Therefore, apart from exploring the link between cognitive empathy and smile judgment performance, future studies could also explore the link between genes and smile

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judgment performance in order to examine the role of genetics in the smile judgment performance.

Like most studies, the current study is not without limitations. Participants were asked if they noticed any symmetrical differences but they were not directly asked if they regarded symmetry as a form of smile judgment cue or if symmetrical differences influenced their smile judgments. Therefore, it is possible that despite being able to detect asymmetry, participants might not have the explicit knowledge regarding the effect of asymmetry on happiness or smile authenticity judgments. Consequently, direct questions about whether symmetry was used as a form of cue should provide clarification on participants' explicit knowledge regarding asymmetry.

Krumhuber, Kappas and Manstead (2013) carried out a review on facial judgment studies and found that the information derived from dynamic cues improved an individual's ability to distinguish authentic facial expressions from fake facial expressions. Seeing as the stimuli used in the current study were static images, this posed a concern regarding the ecological validity of the study as it is possible that some participants who rely more on dynamic cues to judge smiles might perform better when viewing videos of dynamic smiling faces. However, similar smile judgment results were found in a study that presented participants with videoclips of smiles (Chartrand & Gosselin, 2005). This suggested that although dynamic cues might influence smile judgment performance, they might account for a relatively small percentage of individual differences in smile judgment performance.

It has also been found that an individual's beliefs regarding the context in which a smile took place could play a part in influencing smile judgments (Maringer et al., 2011). Furthermore, it has been suggested that prior knowledge regarding a smiling person could be a potential factor that influences smile judgment in real life (Riediger, Studtmann, Westphal, Raters & Weber, 2014). Thus, it is possible that non-static cues could override cues derived

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from static images under certain situations or contexts. Consequently, it is important to acknowledge that individuals might be better at smile judgments in real life seeing as they might be able to combine dynamic cues and context cues when forming their judgments.

### **Conclusion**

To summarize, this study suggested that response options might play a major role in influencing smile judgment, as scores on Likert scales and two-option responses show differences, especially for non-enjoyment smiles. Furthermore, it also demonstrated that the smile judgment responses could not be explained by perceptual-attentional difficulties as no differences were observed in eye movement measures. More importantly, the results showed that whilst individuals had good explicit knowledge regarding the morphological differences, this knowledge was not perfect. In addition, participants also reported changes in areas that did not differ between smiles, further supporting this less than perfect knowledge. Therefore, factors other than explicit knowledge might be in play. In order to better understand these factors, future studies could explore the role of empathy and mimicry, which appears to be linked to genetic components (Uzefovsky et al., 2015), in smile judgment performance.

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## EXPLICIT KNOWLEDGE AND SMILE JUDGMENT

*Table 1.* Mean smile judgment scores and standard deviations as a function of question type and smile type

Question type	Smile type		
	Symmetrical Duchenne	Non-Duchenne	Asymmetrical
Happiness	4.57 (0.61)	3.74 (0.73)	2.03 (0.73)
Authenticity	4.39 (0.63)	3.76 (0.83)	2.22 (0.84)

## EXPLICIT KNOWLEDGE AND SMILE JUDGMENT

*Table 2.* Mean total viewing time (ms) and standard deviations for symmetrical Duchenne smiles, non-Duchenne smiles and asymmetrical smiles in the happiness and authenticity judgment conditions.

Question type	Smile type		
	Symmetrical Duchenne	Non-Duchenne	Asymmetrical
Happiness	4863.32 (1945.04)	4692.44 (1454.50)	5030.07 (2108.69)
Authenticity	4852.22 (1416.52)	4998.14 (1251.69)	4862.82 (1400.25)

## EXPLICIT KNOWLEDGE AND SMILE JUDGMENT

*Table 3.* Mean proportion of time spent viewing the eye and mouth regions and standard deviations as a function of question type, smile type and facial region.

Facial region	Symmetrical Duchenne		Non-Duchenne		Asymmetrical	
	Happiness	Authenticity	Happiness	Authenticity	Happiness	Authenticity
Eyes	0.24 (0.16)	0.24 (0.16)	0.23 (0.18)	0.22 (0.16)	0.25 (0.17)	0.24 (0.18)
Mouth	0.28 (0.19)	0.28 (0.19)	0.27 (0.19)	0.26 (0.18)	0.26 (0.19)	0.25 (0.18)

## EXPLICIT KNOWLEDGE AND SMILE JUDGMENT

*Table 4.* Mean proportion of cues and standard deviations noticed in the eyes, mouth and cheeks as a function of question type, smile type and facial region.

Facial region	Symmetrical Duchenne		Non-Duchenne		Asymmetrical	
	Happiness	Authenticity	Happiness	Authenticity	Happiness	Authenticity
Eyes	0.98 (0.08)	0.96 (0.10)	0.90 (0.23)	0.92 (0.19)	0.97 (0.07)	0.96 (0.09)
Mouth	0.97 (0.07)	0.95 (0.08)	0.95 (0.10)	0.94 (0.09)	0.96 (0.10)	0.95 (0.11)
Cheeks	0.89 (0.17)	0.87 (0.21)	0.79 (0.24)	0.77 (0.25)	0.86 (0.23)	0.87 (0.19)

## EXPLICIT KNOWLEDGE AND SMILE JUDGMENT

*Table 5.* Mean proportion of cues and standard deviations noticed in the eyes, mouth and cheeks as a function of smile type and facial region.

Facial region	Symmetrical Duchenne	Non-Duchenne	Asymmetrical
Eyes	0.97 (0.08)	0.91 (0.21)	0.97 (0.07)
Mouth	0.96 (0.07)	0.94 (0.09)	0.95 (0.10)
Cheeks	0.88 (0.18)	0.78 (0.24)	0.86 (0.21)

## EXPLICIT KNOWLEDGE AND SMILE JUDGMENT

*Table 6.* Mean proportion of cues and standard deviations noticed in the nose, chin and forehead as a function of question type, smile type and facial region.

Facial region	Symmetrical Duchenne		Non-Duchenne		Asymmetrical	
	Happiness	Authenticity	Happiness	Authenticity	Happiness	Authenticity
Nose	0.18 (0.28)	0.17 (0.27)	0.13 (0.25)	0.13 (0.24)	0.16 (0.28)	0.16 (0.30)
Chin	0.35 (0.36)	0.32 (0.34)	0.23 (0.29)	0.21 (0.27)	0.29 (0.31)	0.28 (0.32)
Forehead	0.14 (0.20)	0.14 (0.22)	0.10 (0.19)	0.15 (0.24)	0.14 (0.21)	0.16 (0.24)

## EXPLICIT KNOWLEDGE AND SMILE JUDGMENT

*Table 7.* Mean proportion of cues and standard deviations noticed in the nose, chin and forehead as a function of question type and facial region.

Question type	Nose	Chin	Forehead
Happiness	0.16 (0.26)	0.29 (0.30)	0.13 (0.19)
Authenticity	0.15 (0.27)	0.27 (0.31)	0.15 (0.23)

## EXPLICIT KNOWLEDGE AND SMILE JUDGMENT

*Table 8.* Mean proportion of cues and standard deviations noticed in the nose, chin and forehead as a function of smile type and facial region.

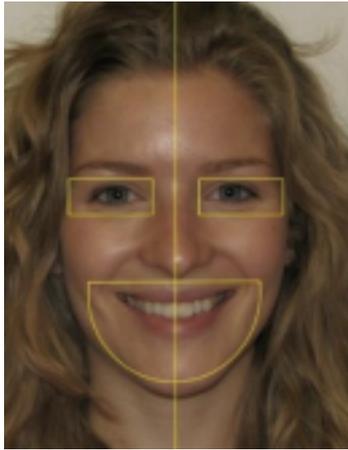
Facial region	Symmetrical Duchenne	Non-Duchenne	Asymmetrical
Nose	0.17 (0.28)	0.13 (0.24)	0.16 (0.28)
Chin	0.34 (0.34)	0.22 (0.28)	0.28 (0.31)
Forehead	0.14 (0.20)	0.13 (0.20)	0.15 (0.22)

## EXPLICIT KNOWLEDGE AND SMILE JUDGMENT

*Table 9.* Mean proportion and standard deviations of the noticed symmetrical differences as a function of question type and smile type.

Question type	Smile type		
	Symmetrical Duchenne	Non-Duchenne	Asymmetrical
Happiness	0.33 (0.30)	0.39 (0.26)	0.64 (0.23)
Authenticity	0.35 (0.30)	0.38 (0.27)	0.66 (0.22)

## EXPLICIT KNOWLEDGE AND SMILE JUDGMENT



*Figure 1:* An example of a symmetrical Duchenne smile (top panel), an asymmetrical smile (middle panel), and a non-Duchenne smile (bottom panel). Examples of the eye and mouth zones are superimposed on the symmetrical Duchenne smile.