# THE ANALYSIS OF EYE-MOVEMENTS IN THE JUDGMENT OF ENJOYMENT AND NON-ENJOYMENT SMILES IN PEOPLE WITH SCHIZOPHRENIA

by

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## ABSTRACT

Research has consistently shown that people with schizophrenia have impairments in emotional facial recognition. This deficit has been associated with irregular visual scanning patterns of the face. Since people have the ability to control the expression of emotion that they display, the communication process becomes more complex. In fact, in addition to processing the emotion expressed, decoders must pay attention to the subtle details about the sincerity of the expression. The goal of the current study was to conduct a systematic examination of the ability and perceptual-attentional mechanisms used in distinguishing enjoyment and non-enjoyment smiles in individuals with schizophrenia. More specifically, the activation of the orbicularis oculi muscle and symmetry was examined. Sixteen individuals diagnosed with schizophrenia and sixteen control (no diagnosis of schizophrenia) were asked to judge the sincerity of smiles while their eye movements were recorded. Individuals with schizophrenia were less accurate than controls in judging the *no-cheek* smile as a non-enjoyment smile. This difficulty could be explained by their bias towards the mouth. Furthermore, like their healthy counterparts, individuals with schizophrenia showed difficulty with the judgement of asymmetric smiles. However, while perceptual processing can be ruled out as an explanation for the difficulty suggesting interpretation problems in control individuals, the former explanation cannot be discredited for individuals with schizophrenia.

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When dealing with facial expressions, smiles are universally linked to the expression of happiness (Ekman, 1971; Izard, 1994). However, since individuals have the ability to control their facial movements as a function of its requirements during various social interactions, smiles can also be used to serve other purposes while communicating (Ekman, 1993; 2001). Consequently, individuals should be able to identify and interpret the differences between enjoyment and non-enjoyment smiles in order to effectively respond to the presentations of smiles. Research has shown that the ability to judge the authenticity of smiles remains modest in the general population. However, results also show that individuals are sensitive to certain cues and that the remaining difficulties are not a result of perceptual limitations (Perron & Roy-Charland, 2013).

What happens in clinical groups? Research has examined people with schizophrenia’s ability to recognize emotional facial expressions and results have indicated that they display impairments with regards to emotion recognition tasks (Archer, Hay, & Young, 1992). Eye-movement studies involving those with schizophrenia have further indicated that they tend to spend less time fixating on the most informative regions of the face, which include the eyes, nose and mouth areas (Gordon, Coyle, Anderson, Healey, Cordaro, Latimer, & Meares, 1992; Phillips & David, 1997). With regards to the judgment of authenticity of expressions, less is known about this clinical population’s performance. It could be expected that this group would have deficits in recognizing the sincerity of expressions leading to maladaptive reactions in a social context. In effect, a person who has schizophrenia’s deficits in emotion recognition may contribute to their poor interpersonal functioning, which in turn may lead to their diminished quality of life

(Bryson, Bell, & Lysaker, 1997; Mandel, Pandey, & Prasad, 1998). Therefore, the purpose of the present study is to explore the ability of those diagnosed with schizophrenia to distinguish between smiles comprising signs of enjoyment as well as signs of non-enjoyment and explore the use of two specific indices of non-enjoyment smiles in the judgment of authenticity using eye-movement recordings.

**Types of Smiles**

Smiles are one of the most commonly produced facial expressions (Abel, 2002) and are recognized cross-culturally as an indication of a positive emotional experience (Ekman & Friesen, 1971; Elfenbein & Ambady, 2002). Authentic smiles have also been associated with increased levels in enjoyment (Ekman, Davidson, & Friesen, 1990), higher ratings of positive moods (Scherer & Ceschi, 2000), as well as neural activity that is similar to those that are shown in a positive emotional state (Davidson, Ekman, Saron, Senulis, & Friesen 1990; Fox & Davidson, 1988). Smiles have commonly been linked to the expression of happiness, however they are also useful for communication purposes (Ekman, 2001), such as masking other felt emotions (Ekman & Friesen, 1982; Ekman et al, 1988), reducing conflict (Ikuta, 1999), or manipulation (Keating & Heltman, 1994). In addition to the spontaneous enjoyment smile associated with the felt emotion of happiness, Ekman (2001) has identified 18 other types of smiles that can be expressed which are each related to various social situations. There are many distinctions between enjoyment smiles that are produced when an individual is truly experiencing a positive feeling compared to a non-enjoyment smile produced voluntarily.

Duchenne de Boulogne (1862/1990) was the first to discuss the properties of an enjoyment smile. With regards to the facial muscles, he observed that enjoyment smiles involved the symmetrical and smooth activation of the orbicularis oculi and the zygomatic major with regular contraction and relaxation. When activated, the orbicularis oculi causes “crow’s feet” at the outer corners of the eyes, raising of the cheeks, bagging of the skin below the eyes, lowering of the eyebrows and narrowing of the eye aperture, while the zygomatic major causes the corners of the mouth to be pulled upwards.

Non-enjoyment smiles are produced by people who intend to send a positive message to others even when they truly do not feel happy (Ekman, 2003). When people display these non-enjoyment smiles, they have been characterized by numerous appearance changes in the facial expression. Of those, research has focused on the activation of the orbicularis oculi muscle (Ekman, Friesen, & O'Sullivan, 1988). Originally it had been labelled a reliable muscle as an indicator for an enjoyment smile since it was thought to be rather difficult to be feigned in order to exhibit false expressions (Ekman, 1985, 1989; Keltner & Bonanno, 1997). Ekman, Roper, and Hagar (1980) conducted a study in which they asked individuals to produce facial expressions intentionally, which involved twelve different facial action units including the orbicularis oculi. Results indicated that only half of the participants were able to activate this muscle deliberately. However, it remains possible to activate this muscle voluntarily. Ambadar, Cohn and Reed (2009) looked at the differences in production of both enjoyment and two types of non-enjoyment smiles (embarrassed/nervous, polite). While the activation of the orbicularis oculi was prominent in 95% of the enjoyment smiles, it was also activated in both the embarrassed/nervous and polite non-enjoyment smiles (64% and 48% respectively). Kanade, Cohn, and Tian (2000) had similar results when they asked their participants to perform a series of facial expressions, including a non-enjoyment smile. When the authors further examined the non-enjoyment smiles, 67% involved the activation of the orbicularis oculi muscle. In sum, while the activation of the orbicularis oculi can be seen in other types of smiles other than the enjoyment smile, it is activated at a less frequent rate in non-enjoyment smiles.

There are also differences in facial asymmetry when comparing smile types. Asymmetry refers to the differences in intensity displayed in the facial muscles that are activated when a facial expression is being produced. In other words, it involves muscle activations that are more intense on one side of the face compared to the other. In relation to a smile, both the orbicularis oculi and the zygomatic major muscles can display asymmetry. Borod, Haywood, and Koff (1997) conducted an extensive literature review of 49 experiments that looked at differences in facial asymmetry for positive and negative expressions. Their goal was to look at whether there were any differences in the level of asymmetry when comparing spontaneous (truly elicited) and posed (elicited through visual or auditory stimulation) facial expressions. They found that there was no significant difference in the frequency of asymmetry displayed between the expression types. However, they did notice that with regards to positive expressions, there tended to be less asymmetry for spontaneous than posed expressions. They concluded that although asymmetry appears to be expressed in both spontaneous and posed facial expressions, there does seem to be evidence (Borod et al., 1997; Ekman, Hager, & Friesen, 1981) that indicates it occurs more frequently in posed expressions.

**Perception of Smiles**

While the literature highlights differences in the production of enjoyment and non-enjoyment smiles, more information is needed to determine whether or not these differences affect how individuals discriminate between smile types. Since the activation of the orbicularis oculi and the level of asymmetry are different between smiles, further research has sought to identify whether these two indices have any impact on judging the authenticity of smiles. Few studies have looked at the judgement of authenticity of smiles as a function of these two indices.

The first study to do so was conducted by Frank, Ekman and Friesen (1993). They were interested in seeing if adults were sensitive to the orbicularis oculi activation as well as the duration of smiles. Decoders were presented with video clips of people smiling when talking about something pleasant (enjoyment smile), or smiling while talking about something unpleasant (non-enjoyment smile). The enjoyment smile involved the simultaneous activation of both the orbicularis oculi and zygomatic major muscles, while the non-enjoyment smile only involved the activation of the zygomatic major. Their results indicated a sensitivity to the orbicularis oculi, where the decoders labelled smiles with the simultaneous activation of both action units more frequently as *truly happy* compared to when just the zygomatic major was activated. A key problem in methodology was that it was impossible to control all the physical parameters of the facial stimuli, which includes such temporal dynamics as the speed and intensity of the muscular actions. Due to this difficulty, they were unable to identify exactly which parameters the decoders were sensitive to. An approach in which the encoders could be instructed to produce very specific facial actions would help better identify which facial parameters individuals are sensitive to.

Gosselin, Perron, Legault, and Campanella (2002) were interested in whether or not individuals perceive the differences between different smile types as well as their knowledge about the signs of authenticity. To create the stimuli for this study, encoders met with FACS experts and were given instructions to voluntarily activate specific facial action units contained in a smile (zygomatic major and orbicularis oculi). The encoders were only being asked to manipulate the action units, meaning no actual emotion was felt. Each type of smile was described and illustrated by the experts. Encoders then practiced the target smiles in a mirror and received feedback from the experts. After a few successful attempts, the encoders were then videotaped while producing each of the different smiles. There were three types of smiles used. The first was the smile containing characteristics of an *enjoyment* smile, involving the symmetric activation of the zygomatic major and orbicularis oculi at moderate intensity. The second type was the *asymmetric* smile, involving the activation of the same muscles but the encoders had to activate them with slightly more intensity (one intensity level difference) on one side of the face than the other. Finally, there was the *no-cheek* smile, which only involved the activation of the zygomatic major at moderate intensity. Decoders were informed that they would be presented 24 short videos showing people smiling and were asked if the person in each video was really happy or just pretending. Results revealed sensitivity to the activation of the orbicularis oculi since participants judged smiles that did not contain its activation as less happy compared to when it did. However, in a supplementary task, only 56.7% indicated differences associated with the orbicularis oculi activation explicitly. With regards to the sensitivity to asymmetry, the decoders judged the *authentic* and *asymmetric* smiles as equally happy meaning they may not see changes associated to the asymmetry or did not interpret it as a sign of authenticity. Therefore, this indicates that we do not know if decoders are encountering perceptual difficulties while attempting to distinguish between smile types, or if these difficulties are associated in interpreting the subtle distinctions between smiles.

In another study, Chartrand and Gosselin (2005) examined the knowledge that adults have of these differences between smile types as well as an emphasis on their perceptive ability to detect them. The same stimuli from the Gosselin et al. (2002) study were used. The decoders took part in two tasks. They were first presented with 54 short videos displaying the three different types of smiles and they had to judge each presentation on a 6-point Likert scale if the person seemed really happy (0-not at all, 6-very happy). They were also asked to evaluate their confidence level for each answer on a Likert scale (0-not at all, 6-very confident). Consistent with the Gosselin et al. (2002) study, results indicated sensitivity to the orbicularis oculi activation, however, contrary to the Gosselin et al. (2002) results, decoders showed sensitivity to asymmetry in that they rated the *asymmetric* smile as less happy than the *authentic* smile and to those without the activation of the orbicularis oculi. The second task presented the decoders with short video clips of 144 paired smiles and they had to judge whether the pairs of smiles were the same or different, as well as their confidence level in order to evaluate their perceptual ability. They were also asked to indicate what areas of the face distinguished enjoyment from non-enjoyment smiles. For this task, half were given information on the appearance changes highlighting the two action units involved in smiles. Results indicated that individuals were able to detect the differences between smiles, but they were better at doing so with asymmetry than the orbicularis oculi. Also, in line with the Gosselin et al (2002) study, participants underestimated changes related to the orbicularis oculi, where only 42% indicated that they actually observed changes in the areas associated with this activation. This suggests that judging smile authenticity is not limited to detection of facial cues involved. Individuals may indicate that they see the differences; however they fail to interpret these differences as signs of authenticity.

Therefore, when we combine the results of the two previous studies, with regards to the activation of the orbicularis oculi, people show sensitivity to this index, however it is modest at best since only half of the decoders seem to indicate they actually observed differences in this area. While participants may show sensitivity related to this index, a possible explanation for modest performance might be associated with difficulties in perceiving the differences, meaning they may not always be able to actually see the difference in its activation between smile types. For asymmetry, the results are inconsistent since both studies revealed differences in sensitivity in relation to this index. The Gosselin et al. (2002) results indicated that the participants judged *symmetric* and *asymmetric* smiles as equally happy, but Chartrand and Gosselin (2005) indicated that participants showed sensitivity to asymmetry, although this was modest.

While these results are in line with the perceptual-attentional limitation hypothesis, which is the belief that individuals have a difficulty seeing the subtle changes exhibited in the different smile types, Chartrand and Gosselin (2005) also suggested that there are other factors, such as explicit knowledge, involved the judgment of smile authenticity. However, a limiting factor in the methodology of the two previous studies involves the task in which the decoders were asked to indicate which areas of the face are different between smile types. Since this was done *post-hoc*, it does not allow us to examine looking behaviour as they are simultaneously judging the smiles. In essence, by asking the participants which areas of the face they indicated were different, the authors are under the assumption that they used these same areas to make their judgments, but that may not be the case. A more efficient procedure to explore an individual's ability to perceive the differences in the indices would involve recording eye-movement which can help indicate which regions of the face are being used during such a task.

Manera, Del Giudice, Grandi, and Colle (2011) examined why individuals differ in their ability to recognize smile types by focusing on the perceptual factors (attention to facial features, action unit discrimination, discrepancy detection) involved in smile recognition through the use of eye-movement recordings where the activation of the orbicularis oculi was manipulated. One type of smile included the orbicularis oculi, one had neutral eyes and the last one included the lip tightener. Eye-movements were recorded to analyze the pattern of visual attention on the face. Overall decoders were about 70% accurate in judging smile types, suggesting participants made use of the perceptual differences between smile types. The eye-movement recordings revealed participants looked significantly longer in the eye region than the mouth region indicating sensitivity to the region when it is activated regardless of whether it included the zygomatic major or the orbicularis oculi. However, the perceptual factors did not come to significance regarding individual differences in smile recognition. More importantly, there was also no correlation between smile recognition and proportion of time spent in the eye region indicating that there is no clear relation between the rate at which enjoyment smiles can be identified and time spent in the eye region. Therefore, these results seem to reject the perceptual-attentional limitation hypothesis, but the analysis does not allow one to compare the differences between smile types since accuracy was combined for all types of smiles. The study also leaves two questions unanswered. First, it does not allow one to conclude if participants are equally accurate among smile types. For instance, while the overall accuracy in correctly identifying the expressions was 70%, this does not indicate how accurate they were with regards to the different smile types. Also, since they seem to spend more time in the eye area for the two previously mentioned smiles, we do not know whether participants are sensitive to the activation of muscles in the eye area, or if they are in fact sensitive to the signs of authenticity.

A study by Calvo, Guiterrez-Garcia, Avero, and Lundqvist (2013) explored the congruency of the eyes with the smile. They examined the attentional patterns for smiles which the eyes were congruent with the smile and smiles where eyes were incongruent. Participants were presented with pictures that depicted an *enjoyment* smile, thus including the activation of the orbicularis oculi and six blended smiles that involved the activation of the zygomatic major combined with neutral, angry, sad, scared or surprised eyes. Their job was to decide whether the person depicting the expression was feeling happy. Results showed that the *enjoyment* smile was judged as happier than all blended smiles. Regarding eye movements, the participants spent more time in the mouth region than the eyes, however, for blended expressions the eye regions were fixated more frequently and longer than those in the *enjoyment* smiles. This would seem to indicate that the presence of the smiling mouth results in a need for additional attentional resources to correctly classify the expressions as non-happy. They concluded that it is not the activation per se to which participants were sensitive, but the congruency of the eyes with the smile. However, in this case, the activation and congruency were again confounded. The smiles with the neutral eyes were combined with the blended smiles with the activation associated with other emotions. Since congruency in the Manera et al. (2011) study and activation in the Calvo et al. (2013) study are confounded, this required further investigation regarding the plausibility of the perceptual-attentional limitation hypothesis.

Perron and Roy-Charland (2013) attempted to examine the perceptual-attentional processes involved during the judgment of smile authenticity through the use of eye-movement recordings. They followed a similar procedure as Gosselin et al. (2002) and Chartrand and Gosselin (2005), with its main purpose of recording eye movements during the judgment of smile authenticity in order to examine the possible perceptual difficulties. If the perceptual-attentional limitation hypothesis was true, individuals would have spent more time viewing the eye area where appearance changes are observed when this index is activated (Boraston et al., 2008; Williams, Senior, David, Loughland, & Gordon, 2001) since it would reveal that they are able the perceive the differences in activation. With regards to the asymmetry, the number of saccades from one side of the face to the other was examined. If individuals reveal a difficulty perceptually distinguishing between asymmetric and symmetric smiles, this would be reflected in similar saccadic patterns from both sides of the face between both smile types. Decoders were asked to judge the authenticity of the smile presented by verbally saying if the expression was *really happy* or *not really happy* all while their eye-movements were recorded.

Results in relation to the orbicularis oculi showed that decoders judged the smiles that contained its activation as happier than those without and were therefore able to use this index effectively, which is consistent with previous studies (Chartrand & Gosselin, 2005; Gosselin et al., 2002). However, contrary to the previous studies, there was no difficulty in properly judging the authenticity of the smile based on its activation. Judgment accuracy for the *no-cheek* smile was 85% and 88% for the *enjoyment* smile. With regards to viewing time, decoders did not spend more time in the eye area in relation to its activation. If individuals had shown difficulties in distinguishing smiles based on this index, it would have been related to less viewing time in the eye area compared to smiles that included its activation. Since viewing times did not differ, this does not support the perceptual-attentional limitation hypothesis, meaning the difficulties associated in processing the orbicularis oculi are not associated with the lack of viewing within the region (Williams et al., 2001). These results actually suggest that there are no difficulties regarding the sensitivity to this index. In fact, one could propose that individuals possess a rapid attentional preference with the eye area that allows one to effectively recognize a relevant social signal of an enjoyment smile indicating the emotional state of happiness (Chartrand & Gosselin, 2005; Owren & Bachorowski, 2001).

Results related to asymmetry revealed judgment difficulties for this index, which is consistent with previous studies (Chartrand & Gosselin, 2005; Gosselin et al., 2002). While decoders judged *asymmetric* smiles as less happy, they were still labelled as happy 72% of the time. Furthermore, data related to eye-movements revealed that decoders made significantly more saccades from one side of the face to the other for the *asymmetric* smiles than for the *enjoymen*t smiles suggesting that they do perceive the difference between smiles, which does not support the perceptual-attentional limitation hypothesis. Since the processing patterns are different for each smile, it can be concluded that individuals can perceive the differences. Therefore, these results indicate a difficulty in relation to the index, which are not perceptual. In line with the Chartrand and Gosselin's (2005) explanation, there are other factors involved, such as not interpreting asymmetry as a sign of non-authenticity, than just viewing the sign. Possible explanations as to why individuals may not interpret asymmetry as a sign of non-authenticity includes the idea that asymmetry in non-enjoyment smiles does not occur very often (Ekman et al., 1981), as well as a certain level of asymmetry expressed in authentic expressions even though it has been shown to be more evident specifically in non-enjoyment smiles (Borod et al., 1997). Since both indices revealed different eye-movement patterns, the difficulty in the judgment of smile types might be in the interpretation of the indices and not perceptual limitations.

While much research has focused on the general population and their perception of enjoyment and non-enjoyment smiles, there has been a recent focus on clinical populations. For instance, people with autism display abnormal processing of social information, specifically when it comes to the recognition of faces and facial expressions translating into performance deficits on face-related tasks (Kanwisher, 2005). More specifically, individuals with autism tend to avoid looking at the eye region when viewing faces which leads to a deficit in the recognition of facial expressions of emotion (Pelphrey, Sasson, Reznick, Paul, Goldman, & Piven, 2002). This lead Boraston, Corden, Miles, Skuse and Blakemore (2008) to investigate the ability of people with autism in distinguishing enjoyment and non-enjoyment smiles. In one task, the decoders were presented with two types of pictures either expressing a genuine or a posed smile, and were asked to decide if the smile was real or posed. The second task involved three types of pictures (neutral, genuine smile, posed smile), where the decoder was asked to decide if each expression was smiling or neutral. Eye-movement recordings were collected for each picture during both tasks. Results indicated that people with autism showed an impairment in the discrimination of posed from genuine smiles. The eye movement recordings also indicated that the people with autism displayed significantly less fixations to the eye region. However, consistent with recent studies (Manera et al., 2011), there was no significant correlation between the judgment accuracy and the percentage of gaze time or fixations relative to the eye region for either group. This suggests that the impairment displayed by people with autism on the discrimination task is not related to their tendency to spend less time looking at the eye region further demonstrating that other factors (Chartrand & Gosselin, 2005; Perron & Roy-Charland, 2013) are involved when discriminating smile types. Since the strategy that people with autism use to recognize facial expressions differs from a non-clinical population, this indicates that the perceptual mechanisms in the judgement of authenticity of smiles varies as a function of population and further research involving other populations would be beneficial.

Therefore, the research that has focused on the perceptual ability in the judgement of authenticity of smiles has highlighted the strategies used by the general population with regards to the indices involved. However, as seen in studies focusing on clinical populations (Boraston et al., 2008), the strategy used may vary as a function of the population. For instance, since those with schizophrenia display impairments with regards to emotion recognition tasks (Archer et al., 1992) and their eye-movement recordings have indicated that they tend to spend less time fixating on the regions important in perceiving smiles, such as the eyes and mouth (Gordon et al, 1992; Phillips & David, 1997), their strategy may differ from others. The perceptual-attentional limitation hypothesis has never yet been tested directly using people with schizophrenia as participants in an eye-movement recording procedure with regards to smile processing. Further research on the strategy implemented by people with schizophrenia dealing with the perception of smile authenticity would be beneficial. The goal of the present study was to explore the ability of people with schizophrenia to distinguish between smiles comprising signs of authenticity as well as signs of non-authenticity and explore the use of two specific indices of non-authentic smiles in the judgment of authenticity using eye-movement recordings.

**Schizophrenia**

Schizophrenia is a mental disorder highlighted by delusions, hallucinations, disorganized speech and behaviours, and other symptoms leading to social or occupational dysfunctions (American Psychiatric Association [APA], 2013). Symptoms that accompany schizophrenia are broken up into two types. One type is known as positive symptoms, which are excess distortion of normal functions. These include hallucinations, delusions, and disordered thoughts and speech, including loose association between ideas, derailment of sentences, incoherence, irrational statements and excessive details. The other type of symptoms are referred to as negative symptoms, which are deficits of normal emotional responses or other thought processes such as flat expressions or little emotion, poverty of speech, inability to experience pleasure, lack of desire to form relationships and lack of motivation. As opposed to positive symptoms, negative symptoms contribute more to the individual’s poor quality of life (Lysaker, Lancaster, Nees, & Davis, 2004; Kirkpatrick, & Fischer, 2006) since it has been shown that negative symptoms last longer than positive symptoms, and are more difficult to treat (Kurtz, 2005;

Alphs, 2006), which can be related to the fact that negative symptoms often are not as responsive to medication (Smith, Weston, & Lieberman, 2010). Also, caregivers of patients with negative symptoms report higher levels of burden (Provencher, & Mueser, 1997). People with schizophrenia are also likely to suffer from other medical conditions, such as depression and anxiety disorders, while approximately 50% of individuals have substance abuse problems (Buckley, Miller, Lehrer, & Castle, 2009). The life expectancy of people with schizophrenia is 12 to 15 years less than those without, which is in direct relation to the increased health problems and higher suicide rate (5%-6%) (van Os & Kapur, 2009; Hor & Taylor, 2010).

Amongst reported factors contributing to the development of schizophrenia, genetic factors have been highly documented (Gottesman, 1993, 2001; Harrison & Weinberger, 2005; Sullivan, 2005; Stone, Faraone, Seidman, Olson, Tsuang, 2005; Picchioni, & Murray, 2007). For instance, those who have a first-degree relative with schizophrenia are at a greatest risk for developing schizophrenia (6.5%), while over 40% of monozygotic twins of those with schizophrenia are also affected (Picchioni, & Murray, 2007). Parents also are a key factor. If one parent is diagnosed with schizophrenia, the child is about 13% more likely to develop it as well, but if both parents are affected the risk is nearly 50% (Gottesman, 2001). In addition to genetic factors, environmental factors have also been reported. The risk of schizophrenia is increased in individuals who suffered childhood trauma, have been separated from their family, have suffered instances of profound bullying or abuse, or lived in an urban environment (Di Forti, Lappin, & Murray, 2007). Other environmental factors that increase the chances of schizophrenia include social isolation, family dysfunction, unemployment, poor housing conditions, and factors related to immigration, such as social adversity and discrimination (Picchioni, & Murray, 2007; Selten, Cantor-Graae, & Kahn, 2007).

The prevalence of schizophrenia is between 0.3%-0.7% in the population. However, variations have been reported as a function of race, gender, and countries (van Os & Kapur, 2009). For example, males are typically diagnosed more often than females (Picchioni, & Murray, 2007). Also, while the prevalence and incidence of schizophrenia is similar around the world, the burden of the illness has its greatest impact in the Oceania, Middle East, East Asia areas, while Australia, Japan, the United States, and most of Europe have the lowest prevalence (Ayuso-Mateos, 2000). The onset of schizophrenia typically begins between the late teens and mid-30s, where the peak age of the first psychotic episode is the early- to mid-20s in males and late-20s in females (American Psychiatric Association [APA], 2013). However, males tend to have more frequent negative symptoms and worse social functioning. For example, Chaves, Seeman, Mari, and Maluf (1993) found that females were better at adapting with the illness and had less disability than males, while Grossman, Harrow, Rosen, Faull, and Strauss (2008) found that females had better global functioning over the course of the illness. Due to the variances within the illness, the course and outcome of schizophrenia cannot be easily predicted and most patients will remain chronically ill for their entire lives. Psychotic symptoms may diminish over the years, while negative symptoms and cognitive deficit may not increase over the course of the illness.

**Theories of Schizophrenia**

Numerous theories have been proposed to explain schizophrenia (Liberman, 1982; McGowan, Lawrence, Sales, Quested, & Grasby, 2004; Schlomer, Del Giudice, Ellis, 2011; Sarin & Wallin, 2014). Of those, the cognitive model stipulated that it is caused by the interaction of existing biological, environmental, cognitive and behavioural factors (Beck & Rector, 2005). Cognitive theorists believe that the cognitive deficits that accompany schizophrenia increase the vulnerability to aversive life experiences leading to dysfunctional beliefs and erratic behaviours. Disorganization results from the cognitive impairments, which includes attentional, working memory, and executive function difficulties (Nuechterlein & Dawson 1984; Walker, Baum, Diforio, 1998), as well as the relative lack of resources available for rules of communication, and preventing disturbance of inappropriate ideas. Delusions are analyzed in terms of the interplay between cognitive biases and resource-sparing strategies. According to the model, origins and explanations for hallucinations and delusions (positive symptoms) would come from the individual's biased information processing. Negative symptoms would come from the interaction of cognitive deficits, personality, and life events which are characterized by negative social and performance beliefs, low expectancies for pleasure and success, and a resource-sparing strategy to conserve limited psychological resources.

Another theory of schizophrenia is based on the biological view in relation to genetic factors (Gottesman, 1993, 2001; Harrison & Weinberger, 2005; Sullivan, 2005; Stoneet al., 2005; Picchioni, & Murray, 2007). Theorists in this field believe that individuals inherit a biological predisposition to schizophrenia and develop the disorder during adolescence as they face extreme stress. Support comes from many different areas. For instance, vulnerability of relatives is a factor. Family studies have indicated that schizophrenia is more common among those who have relatives with the disorder (Stone et al., 2005). In twin studies, results have found that if one identical twin develops schizophrenia there is nearly a 50% chance that the other twin will have it as well, whereas it is only 16% in fraternal twins (Gottesman, 1993). Also, adoptions studies have also indicated a higher percentage of biological relatives of the adoptees with the disorder have been diagnosed with schizophrenia than those of the adoptive relatives (Sullivan, 2005). Finally, genetic linkage and molecular biology is another factor, where various studies have found potential gene deficits on certain chromosomes (Harrison & Weinberger, 2005).

**Treatments of Schizophrenia**

One current support treatment for schizophrenia stems from the cognitive model known as: *cognitive behavioural therapy (CBT)*. CBT's main focus is to help individuals challenge their maladaptive beliefs and replace their cognitive distortions (ie: overgeneralizing, magnifying negatives, minimizing positives) with more realistic and positive thoughts (Hasset & Gevirtz, 2010). Specific in the treatment of schizophrenia, with respect treating positive symptoms such as hallucinations, CBT looks to motivate, engage and explore the problem at hand by asking key questions pertaining to the symptoms (Beck, Rector, Stolar, & Grant, 2008; Wright, Turkington, Kingdon, & Basco, 2009). Questions like: "Is the voice male or female?," and "Where does the voice appear to be coming from?" are used to make the voices seem more understandable in order to stress the idea of *normalization*, where the therapist helps the patient realize that every one, whether healthy or mentally ill, hear voices (Kingdon, & Turkington, 2005; Wright et al., 2009). Therefore, the main goal of CBT in terms of dealing with positive symptoms of schizophrenia is to reduce the negative emotions that the patient associates with them (Barretto, Kayo, Avrichir, Sa, Camargo, Napolitano, Nery, Pinto, Bannwart, Scemes, Di Sarno, & Elkis, 2009).

Another form of treatment for schizophrenia includes the use of antipsychotic medication. There are used to decrease symptoms and increase functioning, and target all symptoms that accompany schizophrenia (positive, negative, cognitive) (Drake, Mueser, Torrey, Miller, Lehman, Bond, Goldman, & Leff, 2000). There are two kinds of antipsychotic medications that are used in the treatment of schizophrenia. The first type is known as *typical* *antipsychotic medications*, and they are effective in reducing positive symptoms (Carpenter, Bernacchio, & Burker, 2013). A major drawback to typical antipsychotic medications is that they have many side effects, such as stress, increased suicidal thoughts, anxiety, substance abuse (Courey, 2007), as well as causing cardiovascular effects and malignant syndrome (Courey, 2007). Another type is known as *atypical antipsychotic medications*, which in addition to treating positive symptoms, are also effective in treating negative symptoms, depression, and quality of life (Leucht, Corves, Arbter, Engel, Li, & Davis, 2009). While the use of antipsychotic medication is beneficial in treating schizophrenia, it is best to use them in combination with other psychological treatment types (van Os & Kapur, 2009).

**Schizophrenia and Perception of Emotion**

One of the key problems associated with schizophrenia is a deficit of emotional responses (Tremeau, 2006), which leads to problems in interpersonal communication including impairments in accuracy when identifying facial expressions (Bryson et al., 1997; Habel, Gur, Mandel, Salloum, Gur, & Scheider, 2000). A possible explanation as to why those diagnosed with schizophrenia suffer impairments in facial perception is related to a disturbance in the strategy used to process facial stimuli. In fact, when eye-movement recordings are monitored, there is evidence that suggests, in comparison to the non-clinical population, people with schizophrenia display abnormal scan paths when processing facial stimuli (Gordon et al., 1992; Phillips & David, 1997; Streit, Wolwer, & Gaebel, 1997).

There is a long documented history of impairments in the recognition of facial expressions with regards to individuals with schizophrenia (Chan, Li, Cheung, & Gong, 2010; Edwards, Pattison, Jackson, & Wales, 2001; Kohler, Walker, Martin, Healey & Moberg, 2010; Mandel et al., 1998; Young, McWeeny, Hay, & Ellis, 1986). One of the earlier studies to look at their ability to judge emotion facial expressions was conducted by Muzekari and Bates (1977). They presented pictures and videos depicting various expressions to people diagnosed with schizophrenia. Both open-ended free responses and multiple-choice alternatives were obtained for each procedure. The first procedure involved two encoders (one male, one female) that posed four facial expressions each: happiness, sadness, anger and fear and the participants were first asked to report what emotion they thought the person was feeling in each picture. Then the same procedure was followed again, but each picture was now accompanied with multiple-choice answers. For the videos, they were presented in black and white without a sound track involving a target person depicting the four previously mentioned expressions as well as “loving,” “liking,” “disappointed,” and “cheerful” scenes. The same procedure for the pictures was followed. In comparison to a non-clinical control group, the schizophrenia group were significantly less accurate in identifying facial expressions for the open-ended and multiple-choice responses for both pictures and videos. With regards to differences pertained to specific emotions during the open-ended responses for pictures, people with schizophrenia were significantly less accurate in identifying both the male and female expressions of sadness, fear and anger, but not happiness. The idea that people with schizophrenia only show deficits in the identification of negative facial expressions has been replicated in further studies (Dougherty, Bartlett, & Izard, 1974; Mandal & Rai, 1987).

However, other studies have also found impairments regarding both positive and negative emotions. Walker, Marwit, and Emory (1980) presented people who were hospitalized with schizophrenia with pictures depicting eight facial expressions: happiness, anger, surprise, disgust, shame, fear, sadness, and interest. The participants were presented with one picture at a time and were asked to label it with one of the eight emotions printed on index cards. Consistent with previous results, in comparison to the non-clinical control group, overall they were significantly less accurate in identifying facial expressions. However, when the accuracy scores were examined for each expression individually, unlike the previous studies mentioned (Dougherty et al, 1974; Mandal & Rai, 1987; Muzekari & Bates, 1977), people with schizophrenia were inferior in terms of accuracy for all eight expressions. The authors suggested that this general facial expression deficit is in line with a theory proposed by Mednick (1958) where those with schizophrenia have a tendency to withdraw socially because they are attempting to guard against exposure to arousing stimuli. However, in doing so, they are reducing their opportunities to observe social and emotional behaviour resulting in eccentric interpretations of facial expressions.

Additionally, Walker et al. (1980) claimed that another reason for the inconsistencies in the results can be due to methodological changes. The mentioned study only made use of the labelling stimulus presentation, whereas both Doughty et al. (1974) and Muzekari and Bates (1977) made use of a free-response mode before the labelling presentation providing those with schizophrenia with an opportunity for practice that could have improved their performance. A more plausible reason for the inconsistencies can be related to the different choice of the sample groups of those diagnosed with schizophrenia. As opposed to Doughty et al (1974), and Muzekary and Bates (1977), the Walker et al. (1980) study involved different methods for selecting their schizophrenia sample and in turn excluded patients who were included be the previous studies. Therefore, the results between the studies could not be comparable.

While most literature has shown that people diagnosed with schizophrenia exhibit a general deficit in facial expression recognition, more recent studies have indicate that it is more emotion specific. Kohler, Turner, Bilker, Brensinger, Siegel, Kanes, Gur, and Gur (2003) presented an outpatient schizophrenia group with color photographs depicting facial expressions of happiness, sadness, anger, fear, disgust and neutral at either high or low intensities. Participants were presented with one picture at a time and were ask to identify the expression. As expected, overall, those diagnosed with schizophrenia performed significantly worse than controls. With regards to intensity, recognition rates were lower in both the low and high intensities for the individuals diagnosed with schizophrenia. Within the schizophrenia group, they had better recognition rates for high intensity for all expressions except for disgust, however, they did not benefit from the intensity change as much as the control group indicating that higher intensities of facial expressions do not help people with schizophrenia better recognize facial expressions. With respect to specific emotions, those with schizophrenia were significantly worse compared to the control group in labelling fear, disgust, and neutral, but not happy, sad, or angry expressions. As in previous studies, happiness was the best recognized expression due to its uniqueness in comparison to other expressions. Since happiness has little overlap in action units (Ekman & Friesen, 1978) compared to the other negative expressions (Kohler, Turner, Gur, & Gur, 2004), this may explain why it is recognized at such a high rate in comparison to other expressions.

Kohler et al. (2010) conducted an extensive literature review that examined all studies published between 1970-2007 regarding the emotional perception abilities of people diagnosed with schizophrenia and the effect of potential methodological, demographic, and clinic moderators. Regarding the inpatient or outpatient status, results revealed that inpatients were more impaired in judgment than both outpatient and mixed groups, however, the number of past and present hospitalizations did not seem to have any impact at all. A strong relationship between age and judgment was found that indicated a later age of onset was correlated with greater impairments in judgment. With regards to antipsychotic medication status, unmedicated patients were the more impaired than both the medicated and mixed groups. Furthermore, those patients that were taking first-generation antipsychotics had more impairments in judgment than both those only taking second-generation antipsychotics and mixed groups.

Much like examining the eye-movements of a non-clinical population, eye-movements can reveal significant information regarding those with schizophrenia's ability to recognition facial expressions. Streit, Wolwer, and Gaebel (1997) analyzed eye movements of inpatients diagnosed with schizophrenia during a facial expression recognition task. Participants were presented with pictures depicting facial expressions of fear, anger, disgust, happiness, sadness and surprise (see Ekman and Friesen, 1976) and were asked to identify the expression while their eye movements were recorded for each picture. Consistent with past studies that have analyzed recognition performance, people with schizophrenia displayed a deficit in comparison to the control group. With respect to the eye movement recordings specifically, people with schizophrenia displayed an abnormal scanpath strategy highlighted by a significantly shorter scan path, longer mean duration of fixations, as well as more frequent fixations to the less salient features of the face. This concept of a minimal scanning strategy was originally described by Silverman (1964) and is highlighted by a narrow and restricted scanning behaviour. This idea of a restricted facial scanpath for people who have schizophrenia has been replicated in many studies (Loughland, Williams, & Gordon, 2002; Phillips & David, 1998; Williams, Loughland, Gordon, & Davidson, 1999). Williams et al. (1999) suggested that people with schizophrenia avoid the salient features of the face because of an emphasis on serial processing where the irrelevant features of the face are treated as equally important as the significant regions and they are unable to focus their attention to feature details in accordance with the demands of facial recognition tasks.

In sum, several researchers have linked emotion recognition deficits with poor social outcomes and day-to-day functioning (Couture, Penn, & Roberts, 2006; Fett, Viechtbauer, Dominguez, Penn, van Os, & Krabbendam, 2011; Hooker & Park, 2002), which are related to main criteria of schizophrenia diagnoses. This is important given that the smile might play an important role in facilitating the development of affective relationship and cooperative bonds (Owren & Bachorowski, 2001). Deficit in recognizing happiness might again contribute to the poor social interactions of individuals with schizophrenia, make them vulnerable to manipulations by others and contribute to their state of paranoia (Larøi, Fonteneau, Mourad, & Raballo, 2010). Furthermore, while the smile is a component of the genuine expression of happiness, it is also a powerful tool to mask and neutralize negative emotions or simulate unfelt happiness, which increases the complexity of the communication (Ekman & O'Sullivan, 2006). To this day, while substantial evidence has been gathered on the impairments in facial expression recognition of basic emotions in individuals with schizophrenia, less is known about their ability to judge the authenticity of the smile.

While past research has focused on the general ability of those diagnosed with schizophrenia to distinguish facial expressions, there is yet to be a study that examines the ability of the population to distinguish the authenticity of smiles. Therefore, the aim of the current study was to conduct a systematic examination of perceptual-attentional mechanisms used in distinguishing *enjoyment* and *non-enjoyment* smiles within the schizophrenia population. This will be accomplished via the exploration of the role of two indices reported in the literature on the production of smiles: the orbicularis oculi and symmetry, through the use of eye-movement recording.

**Hypotheses**

Based on previous research for accuracy, it can be predicted that the control group will judge the *enjoyment* smile as happier than the *no-cheek* smile (Chartrand & Gosselin, 2005; Gosselin et al., 2002; Perron & Roy-Charland, 2013), but for asymmetric, in line with Perron & Roy-Charland's (2013) study, we expect the *asymmetric* smiles to be judged as happier more than the *no-cheek* smiles. In relation to group differences in judgment accuracy (control vs. schizophrenia), based on past research indicating those with schizophrenia have difficulties in accurately identifying emotional facial expressions (Edwards et al., 2001; Mandel et al., 1998; Muzekari & Bates, 1977; Young et al., 1986;), it can be predicted that the schizophrenic group in general will have more difficulties correctly labelling the different smile types. However, since no previous study has examined their ability to correctly label different smile types, we cannot make a statement regarding accuracy in relation to smile type. Also, for the distinction between the probability of answering *really happy* and expected response, based on part research (Perron & Roy-Charland, 2013), for the control group it is expected that for the *asymmetric* smile, the probability of answering *really happy* will be higher than the expected response, with the opposite being true for the *no-cheek* smile. There will be no differences for the *enjoyment* smile. With respect to the experimental group, this will be the first study to examine this property in people with schizophrenia.

Regarding eye-movements with respect to total viewing time for each smile type, based upon previous results (Perron & Roy-Charland, 2013), the control group is expected to spend more time viewing the *asymmetric* smile compared to both the *enjoyment* and *no-cheek* smiles.

No differences between the latter two are expected due to the difficulty associated with the interpretation of the asymmetry index. Since no previous literature has been found related to the experimental group, we are unable to make a prediction on their viewing time based on the different smile types.

Also, with respect to the eye region, based on past research (Perron & Roy-Charland, 2013), it is expected that amongst the control group there will be no differences in time spent looking at the eye region between the smile types. However, in relation to group differences, since research has indicated that those diagnosed with schizophrenia have a tendency to avoid looking at the salient features of the face, such as the eye region, it is expected that the experimental group will spend less time in the eye region as compared to the control group.

With respect to the sensitivity to asymmetry, the number of saccades from one side of the face to the other will be examined. The control group are expected to display more saccades for the *asymmetric* smile than for the other two smile types because they are able to actively perceive the differences between the types of smiles (Perron & Charland, 2013). With respect to the experimental group, this will be the first study to examine this property.

# Method

## Participants

All decoders reported normal or corrected-to-normal vision. There were two groups of decoders. The control (non-clinical) group consisted of 16 undergraduate students (10 females, 6 males; mean age 19 years old) attending Laurentian University. The experimental group consisted of 16 outpatients (2 females, 14 males; mean age 41 years old) diagnosed with schizophrenia receiving services from case management programs at Health Sciences North. Every participant filled out a demographic questionnaire where they indicated their age, gender, visual acuity, and for the control group only they indicated if they currently have, or have ever had a diagnosis of a psychiatric disorder. With respect to exclusion criteria, for the control group, they were excluded if they had a history of psychiatric illness or were currently in treatment with a psychiatric medication. For the experimental group, they were excluded if they had a recent history of substance abuse, epilepsy, neurological disorder, mental retardation, poor visual spatial abilities, significant ocular pathology, or head injury. Also, those prescribed lithium, diazepam, phenytoin, methadone, and barbiturates were excluded due to their effects on the ocular system. Participants were treated in compliance with ethical standards in effect at Laurentian University and Health Sciences North and only those who signed the informed consent took part in the study.

## Materials

The stimuli from Perron and Roy-Charland (2013) were used in the current study, except that four of the six encoders were selected (2 females, 2 males). Materials included 64 pictures of smiling facial expressions that were developed according to criteria set forth by the Facial Action Coding System (Ekman, Friesen & Hager, 2002). The current study used three types of smiles.

The first smile contained characteristics of *enjoyment* smile with the activation of the orbicularis oculi and zygomatic major muscles at intensity D. The second smile was *asymmetric*. The intensity varies from one side of the face to the other for both muscles (C vs. D). Finally, the third smile, *no-cheek*, did not include the activation of the orbicularis oculi but only the zygomatic major was activated (see Figure 1 for examples). The 64 trials included 32 smiles containing characteristics of an enjoyment smile as well as 32 smiles containing characteristics of non-enjoyment smiles (16 asymmetric, 16 no-cheek)

**Apparatus**

Eye movements were recorded with the Eyelink 1000 system. This apparatus is a highly accurate system (<0.5º) that also has a very high sampling rate (2000 Hz). The apparatus has one camera and an infrared sensor. It was placed 70 centimeters in front of the participant at the bottom of the monitor and participants' head movements were controlled via chinrest. One pupil was tracked in the current study and eye selection was defaulted to the participants' right pupil. A nine-point calibration was used and a maximum deviation of one degree in visual angle between both calibrations was deemed satisfactory. After calibration had been established, participants were exposed to the stimuli on a 21'' ViewSonic monitor and at the same time, the experimenter's monitor displayed the participant's gaze position. The gaze position was displayed by a one degree in diameter gaze cursor, which allows examination of the system's accuracy.

**Procedure**

Participants were tested in a single session that lasted approximately 30 minutes. The participants in the control group were tested in the Cognition Laboratory at Laurentian University, while the experimental group was tested at Health Sciences North. Participants in both groups were informed that 64 pictures containing smiles will be presented one after another on the computer screen and that they had the answer whether the smiles were “really happy” or “not really happy”. They were informed that, when they were confident enough in their decision, they should press the mouse button after which they verbally responded (see Perron & Roy-Charland, 2013 for identical judgement task). Once their answer was provided, the next picture was presented. Pictures were presented in randomized order for each participant.

**Data Analysis**

For each analysis an alpha level of .05 was used. The probability of answering “really happy” was computed for each type of smile for each group by dividing the number of times a participant answered “really happy” by the number of occurrences of each type of smile. An analysis was also conducted on expected responses, where participants were expected to answer “really happy” for the enjoyment smile and “not really happy” for the other two types of smiles. The probability of producing the expected response was calculated for each type of smile by dividing the number of expected responses by the number of occurrences of each type of smile. For accuracy, a mixed model ANOVA with group (control vs. experimental) as the between-subject measure and smile type as a repeated measure (enjoyment, asymmetric, no-cheek) was used.

Perception of discriminating indices was observed using eye movement measures. Eye movements were scored with the EyeLink Dataviewer. This program presents participants fixations superimposed on presented stimuli. For each type of smiles, the proportion of time spent on the eyes and the mouth was computed by dividing the time spent in the specified zone by the total time spent on the stimulus. The size of the eye zone is approximately 2.48 by 1.24 degrees in visual angles, and the mouth zone 5.94 by 3.62 (see Figure 1 for example). At least one fixation had to occur in the zone for an observation to be computed, without which an empty cell was recorded. For specified zones, a mixed model ANOVA with group (control vs. experimental) as the between-subject measure and smile type (enjoyment, asymmetric, no-cheek) as a repeated measure was used with the proportion of time as a dependent measure. An analysis was computed on the total viewing time as a function of the type of smile. Total viewing time was computed by adding all fixation durations on the stimulus from the onset of its presentation on the screen to its disappearance. For total viewing time, a mixed model ANOVA with group (control vs. experimental) as the between-subject measure and smile type (enjoyment, asymmetric, no-cheek) as a repeated measure was used. Finally, numbers of saccades from one side of the face to the other were computed where each time the participant's eye crossed an invisible vertical boundary in the middle of the stimulus a saccade was counted regardless of whether the movement was from right to left or left to right. For total saccades, a mixed model ANOVA with group (control vs. experimental) as the between-subject measure and smile type (enjoyment, asymmetric, no-cheek) as a repeated measure was used.

# Results

## Answers

Because of age differences observed between the control group of university students and the clinical group of individuals with schizophrenia, a first series of analyses were conducted with age as a covariate. However, because the pattern of results was identical when this variable was not included, results presented here will not use age as a covariate for sake of comparability with previously published work.

**Probability of answering "really happy".** A mixed-design ANOVA revealed a significant main effect of smile type, $F_{(2,60)} = 231.62$, $\eta^2_p = 0.89$, a significant main effect for group, $F_{(1,30)} = 4.73$, $\eta^2_p = 0.14$, and a significant interaction, $F_{(2,60)} = 14.85$, $\eta^2_p = 0.331$. For simple main effect tests, Dunn's correction was applied to alpha levels, thus to be considered significant the p-value had to be smaller than .03. Results revealed that people with schizophrenia responded significantly more often "really happy" for the *no-cheek* smile than the non-clinical group, $F_{(1,90)} = 23.33$, but there were no significant differences for the other smile types, both Fs < 1. Results revealed differences between types of smiles both for the people with schizophrenia, $F_{(2,30)} = 65.23$, and for the non-clinical group, $F_{(2,30)} = 181.25$. *Post-hoc* tests (LSD) revealed that both groups responded significantly more often "really happy" for the *enjoyment* smile than the *no-cheek* and *asymmetric* smiles, and significantly more often for the *asymmetric* smile than for the *no-cheek* smile.

**Producing the expected response.** A mixed-design ANOVA revealed a significant main effect of smile type, $F_{(2,60)} = 74.69$, $\eta^2_p = 0.71$, a significant main effect for group, $F_{(1,30)} = 12.15$, $\eta^2_p = 0.29$, and a significant interaction, $F_{(2,60)} = 5.56$, $\eta^2_p = 0.16$. For simple main effect tests, Dunn's correction was applied to alpha levels ($p < .03$). Results revealed that participants in the non-clinical group produced the expected response significantly more often for the *no-cheek* smile than people with schizophrenia, $F_{(1,90)} = 22.14$, but there were no significant differences for the other types of smiles, both Fs < 1. Results revealed differences between types of smiles both for the people with schizophrenia, $F_{(2,30)} = 35.97$, and for the non-clinical group, $F_{(2,30)} = 44.28$. *Post-hoc* tests (LSD) revealed that participants from the non-clinical group produced the expected responses significantly more often for the *enjoyment* and *no-cheek* smiles than for the *asymmetric* smile, where the former two did not differ significantly. However, for the participants with schizophrenia, results revealed that they produced the expected responses significantly more often for the *enjoyment* than the *no-cheek* smiles and more for the *no-cheek* than for the *asymmetric* smile.

**Eye Movements**

**Total viewing time.** A mixed-design ANOVA revealed a significant main effect of smile type, $F_{(2,60)} = 6.4$, $\eta^2_p = 0.18$, while both the main effect of group and the interaction were not significant ($F_{(1,30)} < 1$, $p = 0.41$; $F_{(2,60)} = 1.57$, $p = 0.22$). *Post-hoc* tests (LSD) revealed that participants spent significantly more time viewing the *asymmetric* smile than the *enjoyment* smile with no significant differences between the other smiles.

**Time spent in interest zones.** With respect to time spent in the eye area, a mixed-design ANOVA revealed no main effect of smile type, $F_{(2,56)} < 1$, $p = 0.95$, no main effect of group, $F_{(1,28)} < 1$, $p = 0.87$, and no significant interaction, $F_{(2,56)} < 1$, $p = 0.16$. With respect to time spent in mouth area, a mixed-design ANOVA revealed a significant main effect of group, $F_{(1,27)} = 4.12$, $\eta^2_p = 0.13$, while the main effect of smile type and the interaction were not significant ($F_{(2,54)} = 1.89$, $p = 0.16$; $F_{(2,54)} = 2.5$, $p = 0.09$). *Post-hoc* tests (LSD) revealed that people with schizophrenia spent significantly more time in the mouth area compared to the non-clinical group.

**Saccades between sides of faces.** A mixed-design ANOVA revealed a significant main effect of smile type, $F_{(2,60)} = 8.93$, $\eta^2_p = 0.23$, and a significant interaction, $F_{(2,60)} = 7.15$, $\eta^2_p = 0.19$. The main effect of group was not significant, $F_{(1,30)} < 1$, $p = 0.33$. For simple main effect tests, Dunn's correction was applied to alpha levels ($p < .03$). Results revealed that participants in the non-clinical group made significantly more saccades from one side of the face to the other than people with schizophrenia with respect to the *asymmetric* smile, $F_{(1,90)} = 4.73$, with no significant differences for the other smile types, both Fs < 1. Results revealed differences between types of smiles for the non-clinical group, $F_{(2,30)} = 16.03$, but not for people with schizophrenia, $F < 1$. *Post-hoc* tests (LSD) revealed that participants in the non-clinical group made more saccades from one side of the face to the other for the *asymmetric* smile than both the *enjoyment* and *no-cheek* smiles, with no difference between the latter two.

# Discussion

The current study aimed to conduct a systematic examination of perceptual-attentional mechanisms in distinguishing enjoyment and non-enjoyment smiles in people with schizophrenia. More precisely, this was achieved by exploring the role of two indices reported in the literature on the production of smiles: the orbicularis oculi and symmetry, through the use of eye-movement recording during a smile judgment task. This study extended previous research by examining this ability in a clinical population, more specifically in people diagnosed with schizophrenia. Since people with schizophrenia's ability to recognize emotional facial expressions have indicated that they display impairments with regards to emotion recognition tasks (Archer et al., 1992), eye-movement recording can be useful in indicating if their strategy in processing facial expressions is a reason for their impairment. Results pertaining to the orbicularis oculi will be discussed first, followed by those related to asymmetry. Furthermore, in each section, the accuracy in the judgment task for both groups are discussed first, followed by those related to eye-movement recordings.

## Activation of Orbicularis Oculi

With respect to the non-clinical group, participants replicated the results from Perron and Roy-Charland (2013) and judged smiles that contained the orbicularis oculi activation as *happier* compared to those that did not. This once again indicates that adults are sensitive to this index and are also effective in processing the absence of the muscle's activation as a sign of non-enjoyment (Chartrand & Gosselin, 2005; Frank et al., 1993; Gosselin et al., 2002; Manera et al., 2011). Participants also showed no difficulty in expected responses based on this index's activation. Accuracy in the judgment for the *enjoyment* smile was 90% and for the *no-cheek* smile was 93%. Contrary to some of the previous research, no difficulty in judgment of the smile was observed based on the activation of the orbicularis oculi (Chartrand & Gosselin, 2005; Frank et al., 1993; Gosselin et al., 2002), however, this result is in line with what was observed by Perron and Roy-Charland (2013).

With regards to people with schizophrenia, participants also judged smiles that contained the activation of the orbicularis oculi as *happier* than those smiles that did not. However, in relation to the non-clinical group, people with schizophrenia were significantly less accurate in labeling the *no-cheek* smile as "not really happy." While people with schizophrenia were as accurate in judgment for the *enjoyment* smile (88%), with regards to the *no-cheek* smile, they only judged it accurately 63% of the time, as opposed to 93% in the non-clinical group. This result further highlights the difficulty in the judgment of facial expressions in people with schizophrenia (Edwards et al., 2001; Kohler et al., 2003; Mandel et al., 1998; Young et al., 1986) and indicates difficulties in processing this index.

Explanations for the difficulty in the judgement of the *no-cheek* smile can be drawn from eye-movement data. First, with respect to viewing behaviour, for the non-clinical group, results were in line with what was shown in Perron and Roy-Charland (2013), in that participants did not spend more time in the eye area whether the orbicularis oculi was activated or not. Since there was no difference in viewing time based on its activation, this is further evidence that the perceptual-attentional limitation hypothesis (Chartrand & Gosselin, 2005; Gosselin et al., 2002;) is not supported for this process. There were also no differences in viewing times in the eye area between the smile types with respect to people with schizophrenia. However, with respect to the proportion of time spent in the mouth area, people with schizophrenia spent significantly more time in this area compared to the non-clinical group. The idea that a clinical population may spend more time focusing on the mouth region has been shown in other studies (Boraston et al., 2008). Since the eye region contains the important information regarding the activation of the orbicularis oculi (Hager and Ekman, 1985; Williams et al., 2001), and people with schizophrenia seem to have a bias towards the mouth region where information is the same, this can be a reason for lower accuracy in judging the *no-cheek* smiles. More specifically with regards to people with schizophrenia, this result might highlight a disturbance in visual scanning behaviour that would result in the difficulty of identifying facial expressions (Loughland et al., 2002; Phillips & David, 1998; Streit et al., 1997; Williams et al., 1999;).

**Asymmetry**

With respect to the non-clinical group, participants judged the *asymmetric* smile as less happy compared to the *enjoyment* smile. However, they still judged the *asymmetric* smile as "really happy" 61% of the time, which is in line with what was observed in the Perron and Roy-Charland (2013) study, further indicating difficulties associated with the judgment of the asymmetric index (Chartrand & Gosselin, 2005; Gosselin et al., 2002). Eye-movement recordings indicated different processing patterns for the *asymmetric* smile compared to the other types of smiles. Participants made more saccades from one side of the face to the other for the *asymmetric* smile compared to both the *enjoyment* and *no-cheek* smiles, which suggests that they do perceive the differences in types of smiles based on this index (Perron and Roy-Charland, 2013). However, this does not support the perceptual-attentional limitation hypothesis (Chartrand & Gosselin, 2005; Gosselin et al., 2002) since participants did process the smiles differently, meaning they can perceive the differences between smile types. Also, since participants spent more time viewing the *asymmetric* smiles compared to the other types of smiles, a degree of difficulty can be suggested when one attempts to process this index.

When we look at people with schizophrenia, in addition to judging the *asymmetric* smile as less happy compared the *enjoyment* smile, they also judged the *asymmetric* smile as “really happy” more often than not (66%), which is similar to how non-clinical participants judge this type of smile. However, when we examine the eye-movement recordings, differences occur between the groups. With respect to the number of saccades from one side of the face to the other, unlike the non-clinical group, there were no differences between the different smile types for people with schizophrenia. This suggests that people with schizophrenia might not be perceptually as sensitive to the asymmetry as non-clinical control individuals. In other words, while the non-clinical group processed the *asymmetric* smiles differently suggesting that they perceived the differences in comparison to the other types of smiles (Perron & Roy-Charland, 2013), this was not replicated in people with schizophrenia, indicating that they might have difficulties perceiving the changes with respect to this index.

This highlights that the perceptual-attentional limitation hypothesis (Chartrand & Gosselin, 2005; Gosselin et al., 2002) cannot be ruled out as a possible explanation for the difficulty in judging the authenticity of smiles for this specific population. This result could be related to the symptoms that accompany schizophrenia which lead to social dysfunctions, more specifically the deficit of emotional responses (Tremeau, 2006) and impairments in facial expressions recognition (Bryson et al., 1997; Habel et al., 2000) leading to maladaptive reactions in social contexts. Since previous studies that have recorded eye-movements of people with schizophrenia as they look at the happy expression have revealed fewer fixations, longer median fixation durations, shorter scanpath lengths and distance between fixations and less attention to the salient features (Laughland et al., 2002; Streit et al., 1997), these characteristics can lead to why people with schizophrenia have an inability to perceive the asymmetry index or a lack of attention to this index which leads to their deficit in recognizing it as a sign of smile authenticity.

**Limitations and Future Directions**

One aspect of this study that could be viewed as a limitation is the unbalanced gender representation, specifically in the experimental group (14 males, 2 females). While previous research in this field has shown that within the non-clinical population, there are no gender differences in the judgment of enjoyment and non-enjoyment smiles (Frank et al., 1993; Gosselin et al., 2002; Thibault, Gosselin, Brunel and Hess, 2009), the same may not be true for people with schizophrenia. While there is no evidence with regards to gender differences in smile judgement in schizophrenia, literature reviews in the recognition of basic emotions do not suggest gender differences (Chan et al., 2010). Nevertheless, various studies have indicated differences between men and women with schizophrenia with regards to visual processing (Seidman, Goldstein, Goodman, Koren, Turner, Faraone, & Tsuang, 1997), as well as emotional processing (Mendrek, Jiménez, Mancini-Marïe, & Stip. 2011; Mendrek, Mancini, Fahim & Stip, 2007). A study by Mendrek et al. (2007) made use of functional magnetic resonance imaging to show that depending on gender, the parts of the brain that were activated when presented with negative and neutral pictures. When males with schizophrenia processed negative stimuli, the thalamus, cerebellum, temporal occipital and posterior cingulate cortex exhibited higher activations, while in females, higher activations were present in the left middle frontal gyrus.

In fact, when we compare the accuracy ratings between genders in the current study, even though the female sample is small ($n = 2$), they tended to be less accurate than their male counterparts. No strong conclusion can be drawn from the current sample but, since there seems to be a difference in how emotional stimuli are processed as a function of gender in schizophrenia, future studies should look to compare the differences in processing different smile types between males and females with schizophrenia.

Another potential limitation could have been related to the age differences between the control group (mean age: 19) and the clinical group (mean age: 41). However, when the first series of analyses were conducted with age as a covariate, results revealed the same pattern of results than when this variable was not included in the analysis. Consequently, age does not seem to be a factor in the current study.

A final limitation related to the group consisting of people with schizophrenia was related to the different characteristics that vary within the illness, such as different symptomatology, age of onset, duration of illness, and use of medication. Since this was the first study to look at people with schizophrenia’s performance on distinguishing among different types of smiles, we sought the find if they exhibited a general deficit. Other studies have shown variability on facial expression judgment tasks within the population based on those characteristics. For example, Kohler and colleagues (2010) found that individuals developing schizophrenia at a later age showed greater impairments, and those who were taking typical antipsychotics showed greater impairments in facial expression recognition compared to those who took atypical antipsychotics and mixed groups. Therefore, future studies should look to determine if there are any differences in distinguishing between smiles types based on those characteristics.

Future research should also focus on exploring the role of explicit knowledge about the cues and the link between the knowledge of these cues and the judgement of authenticity. In fact, social experiences that are related to the knowledge indicating asymmetry as a sign of non-enjoyment are rare (Chartrand & Gosselin, 2005). Ekman et al. (1981) reported that asymmetry only occurred occasionally in non-enjoyment smiles. Also, other studies have indicated the presence of asymmetry in enjoyment smiles as well (Borod et al., 1997). Therefore, the inconsistency that stems from asymmetry may lead to the increased difficulties with respect to processing the index while people with schizophrenia attempt to judge different smile types. Consequently, future research should explore what knowledge individuals with schizophrenia have about the presence of asymmetry in non-enjoyment smiles and the use they make of this information in their judgement.

## Conclusion

In sum, individuals with schizophrenia are less accurate at judging the authenticity of smiles, at least, for smiles that do not comprise the activation of the orbicularis oculi. Most importantly, the current study revealed that opposite to the non-clinical population, the perceptual-attentional limitation hypothesis cannot be ruled out as an explanation for the difficulty in judging smiles types in people with schizophrenia. The results indicate that people with schizophrenia may not as accurately perceive the differences with respect to the activation of the orbicularis oculi muscle and the presence of asymmetry in the expression. Further research should look into gender differences with regards to the judgment of smile types in relation to schizophrenia. Furthermore, a focus on exploring the role of explicit knowledge about the cues in order to find a potential link between the knowledge of cues and the judgement of authenticity within the schizophrenia population would also be advantageous.

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Table 1. Means and standard deviations for accuracy, viewing time, proportion of time spent in the eyes, proportion of time spend in the mouth and number of saccades from one side of the face to the other for the control and schizophrenia groups as a function of the types of smiles.

| | Group | | | | | |
|---|---|---|---|---|---|---|
| | Control | | | Schizophrenia | | |
| Measures | Symmetric Duchenne | Non-Duchenne | Asymmetric | Symmetric Duchenne | Non-Duchenne | Asymmetric |
| Accuracy | .90 (.10) | .93 (.11) | .39 (.21) | .88 (.10) | .63 (.27) | .33 (.22) |
| Viewing Time | 2638 (1209) | 2144 (977) | 2912 (1296) | 2936 (1838) | 2882 (1453) | 3179 (2172) |
| Prop. Time in Eyes | .38 (.13) | .34 (.17) | .35 (.19) | .35 (.20) | .38 (.24) | .38 (.20) |
| Prop. Time in Mouth | .37 (.12) | .38 (.15) | .37 (.12) | .52 (.16) | .45 (.16) | .47 (.18) |
| Saccades | 2.73 (1.56) | 2.16 (1.53) | 3.53 (1.92) | 2.26 (1.78) | 2.21 (1.49) | 2.29 (1.77) |

Figure 1.

An example of an *enjoyment* smile (zygomatic major and orbicularis oculi activated symmetrically) is presented in the upper panel, one with *asymmetric* activation is presented in the middle panel, and *no-cheek* smile without the orbicularis oculi activation is presented in the lower panel. Examples of the zones are superimposed on the enjoyment smile.

## Appendix A: Letters of Ethics Approval

LaurentianUniversity
UniversitéLaurentienne

**APPROVAL FOR CONDUCTING RESEARCH INVOLVING HUMAN SUBJECTS**
Research Ethics Board – Laurentian University

This letter confirms that the research project identified below has successfully passed the ethics review by the Laurentian University Research Ethics Board (REB). Your ethics approval date, other milestone dates, and any special conditions for your project are indicated below.

| TYPE OF APPROVAL / New X / Modifications to project / Time extension | |
|---|---|
| **Name of Principal Investigator and school/department** | R.J. Ryan |
| **Title of Project** | ***Analysis of Eye-Movements in the Judgment of the Authenticity of Smiles in Schizophrenics*** |
| **REB file number** | 2013-07-09 |
| **Date of original approval of project** | October 3, 2013 |
| **Date of approval of project modifications or extension *(if applicable)*** | |
| **Final/Interim report due on** | October 3, 2014 and annually |
| **Conditions placed on project** | Final report due on le October 3, 2015 |

During the course of your research, no deviations from, or changes to, the protocol, recruitment or consent forms may be initiated without prior written approval from the REB. If you wish to modify your research project, please refer to the Research Ethics website to complete the appropriate REB form.

All projects must submit a report to REB at least once per year. If involvement with human participants continues for longer than one year (e.g. you have not completed the objectives of the study and have not yet terminated contact with the participants, except for feedback of final results to participants), you must request an extension using the appropriate REB form.

In all cases, please ensure that your research complies with Tri-Council Policy Statement (TCPS). Also please quote your REB file number on all future correspondence with the REB office.

Congratulations and best of luck in conducting your research.

Susan James

Susan James, Chair
Laurentian University Research Ethics Board

Health Sciences North
Horizon Santé-Nord

Research Ethics Office
Children's Treatment Centre
Rooms C905-C911
41 Ramsey Lake Road
Sudbury, ON P3E 5J1
t: 705-522-6237, ext. 2409
email: reb@hsnsudbury.ca

| | |
|---|---|
| To: | Dr. Albert Gouge (student: Randal Ryan) |
| Study Title: | Analysis of Eye-Movements in the Judgement of the Authenticity of Smiles in Schizophrenics |
| Sponsor/Funding Agency: | Not Funded |
| REB Review Type: | Full Board |
| Date of Meeting: | January 6, 2014 |
| **Expiry Date:** | **January 6, 2015** |

**Notification of REB Initial Approval**

**Documents Approved**
Instructions for Participants
Informed Consent for Participation in a Research Study
Study Protocol
Research Outline version 1.01

**Documents Approved with Revisions**
Letter of Information to Research Participants

**Documents Acknowledged**
Laurentian University REB approval

*Project Number: 958*

The Research Ethics Board of Health Sciences North (REB HSN) has reviewed the above research protocol. The quorum for approval did not involve any member associated with this project.

The above Project Identification Number has been assigned to your project. Please use this number on all future correspondence.

The REB suggested the following:

1. Consider changing the second sentence in the letter of information given to the schizophrenic patients to read "I am conducting a research study that is interested in better understanding how people with schizophrenia view and process smiles."

Once you have revised the above document, please submit an Amendment Request Form to the Research Ethics Office in order that it may be approved through our delegated review process.

If, during the course of the research, there are any serious adverse events, confidentiality concerns, changes in the approved project, or any new information that must be considered with respect to the project, these should be brought to the immediate attention of the REB. The relevant forms may be found on the HSN's intranet site, but may also be obtained from our office upon request in the event that you do not have access to same.

In the event of a privacy breach, you are responsible for reporting the breach to the HSN Privacy Officer.

If the study is expected to continue beyond the expiry date, you are responsible for ensuring the study receives re-approval. The REB must be notified of the completion or termination of this study and a final report provided.

The Board wishes you good luck with your study.

Sincerely,

Dr. Martin Shine, Chair, Health Sciences North Research Ethics Board