Do face masks impair facial emotional recognition?

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Abstract

Background: As the presence of facemasks has arisen during the time of Covid-19 (Scarpina, 2020) where little is known about the impact facemasks has on communication by reduced visual information presented through facial expressions. This current study tested differences between emotion recognition of faces which were masked and unmasked; differences between sex accuracy rates overall and if self-perceptions interacted with emotional accuracy scores of faces. *Methods:* 165 Participants were recruited through convenience sampling (Facebook) whereby access to a google forms questionnaire, recorded participants responses. Measuring self-perceptions of facemasks and emotional recognition accuracy scores of faces taken from the MPI Faces dataset (Ebner, Riediger & Lindenberger, 2010) based on six emotions (happy, sad, fear, neutrality, anger, disgust). *Results*: Indicated significant negative effects to masked faces accuracy; additionally, sex and self-perception where non-significant in differences affecting accuracy scores. *Limitations:* The sample was distributed irregularly, and poor internal validity (Pallant, 2013) reduced findings significance. *Conclusions:* Suggest masks inhibit recognition of emotions to a small effect on interpretations which may affect communication of emotion. *Implications:* Further research should be directed to adaptive measures for individuals which rely on facial cues to guide emotional understanding and communication as facemask usage reduces clarity in communication.

Contents

Introduction

This literature review will investigate various aspects of emotional recognition by providing an overview of emotional functions, biological aspects of emotion, expressive communication of emotion, and psychological factors that influence emotion processing; subsequently evolving to more recent studies of emotional communication through facial expressions.

Emotional Functions

Early classifications of basic emotions were termed "The Big Six" (Ekman, Sorenson & Friesen, 1969) and classified emotions as "happiness, sadness, fear, surprise, anger, and disgust". Darwin and Prodger (1998) and Jesus (2009) have suggested that these basic emotions are adaptive in nature. Consistent with this, these emotions were more recently defined as the root foundations that emotions stem from, and are "*innate, universal, and distinct affective states which evolved to serve adaptive functions*" (Kowalska & Wróbel, 2017, p. 1). The "Prime" or "Readout" theory by Buck (1985) provided links to emotional functions identified as "Primes", motives addressing emotional reactions that are utilised for communication of information to others. Linking into Descartes (1988) theory that emotions provide primal functions for communication. This theory highlights the concept of voluntary and involuntary emotions as forms of behavioural language as suggested later by Buck (1994); emotions can be altered by physiological and psychological information adapting meanings for others to interpret the data. Later research suggests (Wilson-Mendenhall, Barrett & Barsalou, 2013; Gu, Wang, Patel, Bourgeois & Huang, 2019) emotion is categorised into biological and psychological aspects of emotion.

Biological Factors

Biological factors that shape emotion perceptions include age and sex. Ekman (1992) suggests that emotions are interpreted through "automatic appraisal" (Ekman, 1992) inferring that recognition of emotion is a rehearsed pattern reflex of an individual. This suggests that information is judged by an individual. However, research suggests age groups subject individuals to bias as identified by Wright and Stroud (2002) as recognising faces were easily identifiable to individuals within similar age groups except in criminal activity. Investigated further by Harrison and Hole (2009) included race and peer age group effects to individual's perception accuracy ratings finding similar results in age group bias. Harrison and Hole (2009) additionally, noted teachers had no bias present in identifying faces of young adults or children suggesting occupation may reduce recognition bias of faces. Highlighting that possible exposure to more facial expressions and training could affect rates of facial recognition accuracy.

Research on the impact of biological sex on emotion recognition has also shown interesting results. In one study, Alwall, Johansson and Hansen (2010) identified that compared to males; females had improved eye gaze cueing effect, resulting in faster reaction speeds during an emotional recognition task; specifically, females showed greater attention to detail in classifications of emotion. A later meta-analysis by Kirkland, Peterson, Baker, Miller and Pulos (2013) supports the findings to a small effect that females tend to be stronger in emotion recognition. Kirkland et al., (2013) analysis, identified studies where males and females completed the Reading the Mind in the Eyes Test (Baron-Cohen, Wheelwright, Hill, Raste & Plumb, 2001) showing favourable accuracy results for females. Further, finding results similar to that of both scores in infancy (Leeb & Rejskind, 2004), reading non-verbal cues (Hall, 1978) and minimal information (Hall & Matsumoto, 2004)

where females scored higher showing sex can affect performance rates when classifying emotions with facial information.

Further studies support the idea that sex differences are found by Thayer and Johnsen (2000) where a multivariate study identified that females compared to males scored less errors when labelling emotional faces represented by either sex. A limitation was a small sample of 44 participants. A strength of this study was the focus on sex differences in emotional interpretation and incorporated arousal effects that alter interpretations (Thayer & Johnsen, 2000) such as attraction.

These findings were also supported by Herlitz and Lovén (2013) who found that females can recall faces more accurately than men. Through these past analyses it shows that sex differences may lead to differences in performance accuracy when categorising emotions. Concurred by Rattel, Mauss, Liedlgruber and Wilhelm (2020) who investigated sex differences where participants of both sexes were exposed to a brief film measuring physiological and psychological responses; finding female's self-report stated heightened arousal and effecting breathing rates in response to the film highlighting awareness responses. However, a rebuttal by Di Tella, Miti, Ardito and Adenzato (2020) found there was no difference between males and females in cognitive tasks; only that females scored higher in empathy and aggression detection. Concurred by Carbon (2020) who researched the effectiveness of facemasks on perception of emotion recognition; finding no affects in sex difference in accuracy in identifying emotions covered by masks inhibiting facial reading of traditional cues such as the mouth. A strength of this study was the measures of the "MPI Faces dataset" (Ebner et al., 2010) that Carbon (2020) adapted to identify differences caused by face masks. However, a limitation to Carbon's (2020) research was that the focus was split on demographics, socio economic factors, perceptions, age, and accuracies creating a broad overview of the area. This research was important as it highlights conflicts in research as sex

differences may be present in the population or unsupported due to group participant differences in sample data collected.

An additional biological factor that shapes emotion perceptions include age group. Isaacowitz et al. (2007) found that discrepancies in understanding of visual representations of emotions such as “aggression” and “fear” increased with age. An interesting finding in recent research by Carbon (2020) supports the idea that misinterpretations occur between some emotions e.g., disgust and aggression, as these negative emotions can be classified similar by others even though meanings are different.

Communication

The role of communication is separated between verbal and non-verbal. Verbal communication involves the use of language (Cartier & Harwood, 1953) and non-verbal communication defined by Wiener, Devoe, Rubinow and Geller (1972) using facial cues, gestures, and signs to depict information to others or to further individual understanding. However, in present studies moving away from this definition of non-verbal communication by Wiener et al., (1972) which was challenged prior by Ekman and Friesen(1967) suggested it was restrictive to facial cues affecting emotional responsiveness. This definition of non-verbal communication (Wiener et al., 1972) has been challenged by linguistics e.g., a review by Bavelas and Chovil (2000) suggested that these types of communication should be more holistic as they feature an intertwined role in providing expression of communication.

Yet, the definition has led to increased interest in observable behaviours of non-verbal communication applied to various fields or settings e.g., counselling techniques suggested by Kraus (2011) for client awareness and perceptions; however, professionals may lack training on awareness of these cues or cultural diversities as they may vary widely in communication expressed by an individual; and seen as observable in behavioural settings (Burgoon,

Guerrero & Manusov, 2016). This form of communication has been adapted and refinements have progressed through society suggested by Buck (2019) and reflective in the research.

Non-verbal cues are seen in a variety of different fields from behaviourists e.g., justice system (Denault et al., 2020). However, Denault et al. (2020) identified in a review, problems with non-verbal cues as they are based on the assumption of how interpretations can provide understanding to individuals; similar to the Reid technique (Buckley, 2006) used in America that behaviours observed can provide cues to base judgements on true or false information. This trained technique identified by Denault et al. (2020) suggests the foundations of its teachings reflect that many people learn subconsciously or formulate beliefs through experience of generating ways of judgement through communication. This is important as it suggests that non-verbal communication is interpreted subjectively. An example by Schrage, Maxwell, Impett, Keltner and MacDonald (2020) investigated non-verbal cues that may be identified as affection cues on facial representations to help people with avoidant attachment styles. To see if recognition of cues may help form relationships with others by being able to identify behaviours suggesting affection. The results from Schrage et al., (2020) found that if individuals were more perceptive to cues; and able to classify them as a behaviour than verbal communication. An interesting part of this study was results suggested participants reported more intense feelings of positive emotion with non-verbal cues in 280 couples; suggesting emotions are felt subjectively, and intensity differed amongst individuals based on preferred communication.

Psychological Factors

The impact of psychological factors on emotion studied by Breiter et al., (1996) documented the amygdala and fusiform gyrus which altered interpretations of fear and happiness depicted through non-verbal expressions. These findings were supported by Elliot

et al. (2014) who identified that mothers with bipolar personality disorder (BPD) found identifying infants moods more difficult compared to mothers without (BPD). This shows that faces are interpreted differently by the mother dependant on mood-based expressions; and demonstrates how personality traits can alter responses incorrectly identifying stimuli such as “neutral faces” (Elliot et al., 2014). Similarly, Gillespie et al. (2019) tested convicts with psychopathy and found that interpretations of fear were more challenging to those with this personality type. Gillespie et al. (2019) highlights how attentional focus on attributes or cues influence perceptions of judgement by focusing on areas where expectations of information are to be supplied.

Allen-Walker and Beaton (2015) adapted empathy scales to identify if personalities have influences over identifying expressions of emotion. Resulting with no underlying relationship between recognition and empathy of emotion (Allen-Walker & Beaton, 2015). In addition, traumas can also affect the rate, correctly identifying emotional patterns on faces as studied by Jackson and Moffat (1987) where participants had suffered localised brain injuries had resulted in misinterpretations of negative stimuli. Other psychological stressors such as “PTSD” by Pfaltz et al. (2019) did not interfere with emotional face labelling, finding no disparities between groups with and without PTSD correctly depicting neutral expressions of emotion. Though childhood abuse was linked higher for contempt and sexual abuse was more significantly related to identified aggression (Pfaltz et al., 2019) which illustrated personal experience can affect perceptions of visual data.

Johnson, Waugh, and Fredrickson (2010) highlighted how emotional expressions are learned and that prevalence rates of “smiles” “positively” effect “visual processing” speed (Johnson, Waugh, & Fredrickson, 2010) showing effects on individuals emotions and transferability to social settings. “Positive emotions become less recognizable, and negative emotions are amplified” (Spitzer, 2020) in a school setting wearing face masks. A

counter study by Scarpina (2020) examined the effects fearful expression detection amongst the time of Covid-19 finding no difference of speed comparison of neutral or fearful expressions.

Facemasks

Research by Schünemann et al., (2020) suggests the positives of facemask usage for protection of Covid-19. However, additional information is needed to address the research gaps and risks to the individual for increased face mask usage, such as possible fatigue (Atangana & Atangana, 2020) which could enable discomfort and irritability for an individual. Research in this area has focused on the environmental impact of face mask fabric (Fadare & Okoffo, 2020; Alenezi, Cam & Edirisinghe, 2020) and protective benefits, although the social aspect of face masks should be incorporated with face masks design and manufacturing to ensure protection for efficient and effective communication. Such as fabric visibility to enable effective communication amongst individuals (Atcherson et al., 2017) helping those who may be dependent on facial gestures for contextual information. As contextual information regarding Covid-19 (Cardiff & Kehoe, 2020; Mehta, Venkatasubramanian & Chandra, 2020) increases awareness identifying possible divides in education and learning. However, further analyses are needed regarding possible barriers facemasks pose to individuals. As facemask prevalence has increased within the population guided by government recommendations and health advisories (World Health Organization, 2020) endorsing facemask usage.

Review Summary

Many people are working in sectors where masks are compulsory to protect others such as medical and educational environments e.g., clinicians, carers, and teachers (Sun et al., 2020; Spitzer, 2020). Robinson et al. (2019) highlighted the importance of social expressions in environments. Smyth's (1998) emotional expression was challenged by face masks inhibiting facial expressions as seen in recent research by Carbon's (2020) results indicated inaccuracies which lead to misidentifying emotions e.g., disgust and aggression. This is important as it suggests a gap in research that needs to be addressed in relation to the role of sex, communication, and facemasks affecting emotional understanding in communication. Additionally, as research has suggested that sex differences may be small in effecting perceptions of emotion in favour of females (Kirkland et al., 2013). Non-verbal cues read by others may be stronger in intensity of registering emotion when deferring classifications of emotions displayed (Schrage et al., 2020). Also, non-verbal communication is observable, yet it can affect interpretations varying on attentional focus (Alwall et al., 2010; Gillespie et al., 2019). Additionally, face masks inhibited accuracy in perception of negative emotions e.g., disgust and aggression which were integrated into one classification of negative emotion (Carbon, 2020). Research in this topic has suggested that emotions are influenced by age, sex, history, and settings which affected perceived emotional responses.

Rational and Hypothesis

This current study is significant to applying contextual aspects in relation to individuals and adaptive effects facemasks have presented to emotional recognition (Carbon, 2020). Research into facemasks during Covid-19 (Scarpina, 2020) suggested aspects requiring further investigation. As Di Tella et al., (2020) found gender discrepancies for females in aggression detection during Covid-19 supporting Carbon (2020) findings of heightened aggression awareness with the prevalence of facemasks. However, Scarpina (2020) tested for fear detection which had not increased during the time of Covid-19.

The suggestive idea of sex and negative emotion identification has raised interest in these areas for the current study. As research by Rueckert and Naybar (2008) identified females were more accurate on empathy levels as concurred by Alwall et al., (2010). Where research by Kirkland et al., (2013) indicated adaptive features may have impacted accuracy in detection such as speed of processing and gaze effects. However, more recent research by Carbon (2020) integrating emotional recognition and facemask presentation showed no discrepancies between sex, conflicting with prior research where females are suggested to out-perform in the task. Possibly explained if facemasks reduced emotional accuracy when restricted to still images of facial expressions without supplementary cues, highlighting interest on sex differences in the current study.

Further support for the importance of the current study was the impact facemasks have on the field of communication and linguistics as suggested by Sun et al. (2020), little is known of social implications of facemasks as (Carbon, 2020; Di Tella et al., 2020) negative emotions are heightened in prevalence which could affect interpretations of others. As suggested by Spitzer (2020) and Mehta et al., (2020) emotion information was important to understand and empathise with individuals in roles of care, education, and medical settings.

Hence, the current study aims to investigate facemasks implications and applications in social and workplace aspects influencing emotional expressions. By allowing for comparisons using photos of unmasked and masked faces in a questionnaire, detecting any confounding factors such as sex and self-perceptions which may alter emotional accuracy. Guided by past research by Carbon (2020) concurred by Spitzer (2020) there are many new challenges faced through increased usage of face masks.

As higher prevalence for use of face masks due to government and health guidance (World Health Organization, 2020) could shape perceptions and influence results. This research hopes to understand adaptive responses and what it would mean to the population in terms of what emotions are portrayed and how they are interpreted.

The three hypotheses for this study are:

1) If face masks are worn, then emotional reading of facial expressions will become impaired?

2) If adults wear masks will this cause different reactions amongst gender interpretations of emotional expressions perceived?

3) Does peoples scores on a self-perception scale predict performance accuracy in classifying emotions?

Methods

For this current research, a quantitative methodology was chosen as it was the most appropriate technique for acquiring information to explore the research question and test the hypothesis of the study. Providing an objective standardised measurement which could be replicated and validated accordingly. Allowing for contextual information into effects of facemasks to be gathered, compared, and observed through the collected data using a questionnaire.

Participants

Sample size for this experimental study was calculated through reference to a formula by Tabachnick, Fidell and Ullman (2007)"Pv's x 15 participants = sample size" acknowledging variables (Criterion variable: Total Emotional Accuracy, Predictor variables: Self-perception questions 3,4,5,7,8,9,10) , 7x15 = 105 minimum participants needed. Participants were recruited using a link posted on the researchers Facebook page. This generated interest for participating in the study to explore emotion recognition of faces both masked and unmasked and provided access to the questionnaire on google forms. The acquired participant size was N=165, male (52), female(111) and other (2) ranging from 18-79 years old (M = 35.96, SD =16.10). These participants were of acceptable age range and accepted as they could provide informed consent allowing valid data collection. The only excluded data was 2 participants from the 'other' category, when examining sex differences in hypothesis 2 as the participants sample size was insufficient to generate data on sex differences (N=163). However, their data was incorporated in the hypothesis 1 and 3.

Measures

The measures for assessing individuals were separated into three subsections demographics, self-perceptions, and emotional recognition scale. These enabled comparisons

to be drawn from participants responses and exploration of the research questions through quantifiable measures.

Demographics. Where collected from participants through a questionnaire which provided sex (male, female, other, prefer not to say) and age. Participants were also asked to provide contextual information on facemasks settings through a 2-item scale (Q6, Q11). Where responses gathered by participants provided background information of facemask place of usage separated into themes (workplace setting, healthcare setting, shopping, public transport, other) (appendix C).

Self-perception scale. Participants were measured on a self-perception scale generated by the researcher which consisted of 7-item scale in relation to communication and facemasks. Q3 to provide duration of facemask usage measured using 5-point Likert scale (0 = 0 hours to 4 = 4 hours or more). Q4 and Q5 examined communication with an exploratory view of self-perceptions measured using choice answers (1 = yes, 2 = no) of communication from self and others. Q7 and Q10 measured communication statements of facemasks affecting communication and care (1 = strongly agree to 5 = strongly disagree). Q8 and Q9 measured miscommunication and care received by others with facemask presence with a 5-point scale (1 = very rarely to 5 = very often). These questions were pilot tested by 2 individual participants who scanned and checked for errors in the questionnaire. The Cronbach's alpha was (α =.521) showing a poor internal consistency for questions (Pallant, 2013), however, these questions were accepted as they were utilised for background information within the samples perception of facemasks and relevant for predictive qualities of the samples emotional accuracy.

Emotional Recognition Scale. Participants were measured on emotional accuracy of faces displayed to the individual. Where emotions were depicted on faces based on the six key emotions suggested by "The Big Six" by Ekman et al., (1969) "happi-ness, sadness, fear,

surprise, anger, and disgust" (Kowalska & Wróbel, 2017). The emotions used in this current study are happy, sad, fear, neutrality, anger, and disgust produced by Ebner et al., (2010) as they were available. Based on previous works by Carbon (2020) which used a larger scale of faces produced by Ebner et al., (2010). In the current study only twelve photos were selected from the MPI Faces dataset (Ebner et al., 2010) as to prevent possible questionnaire fatigue. A male and female both from the middle-aged category where selected to generate the faces. These were duplicated and adapted with facemasks added to them. Controlling emotions as the depiction of facial expressions were identical which enabled comparisons between masked and unmasked photos providing reliable testing. The Emotional Recognition Scale used these 24 photos in total, each with the counterpart of the emotion depicted to create a score. The correct emotion and three varying incorrect emotions giving a multiple choice of four possible options for each face. In this current sample the Cronbach's alpha was (α =.359) overall for 24 items. These were broken down to separate subsets unmasked faces (α =.192) and masked faces (α =.116 with 3 variables excluded due to no variance Q27, Q29, Q33). These illustrated a poor measure of internal consistency (Pallant, 2013). However, they were accepted as a valid measure with caution for result meanings.

Materials

Materials required for this study include SPSS statical manual by Pallant (2013), 12 photos expressions from "MPI Faces dataset" (Ebner et al., 2010) with an account to utilise photos for research and photoshop for generating 12 masked faces (Carbon, 2020). A Facebook account for recruitment with a google account to use forms to generate the questionnaire and for data collection. IBM SPSS Statistics version 25 (Lin, 2020) was used for statistical analysis, participant information/consent and debriefing sheet (see appendix A, B, and D) were used to inform participants about the questionnaire (see appendix C) and rights to the individual participating. Additionally, a scoring Key of MPI Faces (Ebner et al.,

2010) was used to evaluate accuracy of emotion recognition with the emotions for each face (appendix F).

Design

This current research was a quantitative, cross-sectional design conducted to examine the three main hypothesises. First hypothesis was conducted with a within groups design, analysed by the independent variable (IV) unmasked faces and masked faces on the Dependant variable (DV) emotional accuracy scores for each. Second hypothesis was a between groups design, analysed by (IV) sex and (DV) total accuracy scores overall. Third hypothesis was conducted by a between-participants design which analysed the criterion variable total accuracy scores overall and the predictor variables were self-perception scores of questions (3,4, 5, 7, 8, 9, 10).

Procedures

Participants were introduced to the study by a link provided by the researcher on Facebook to a google forms questionnaire. A small blurb was provided on Facebook to gain interest and provide contact details e.g., name and email for questions. Prior to a redirection to the google forms questionnaire, which greeted participants to the information and consent sheet (appendix A, B) detailing the aim of the study overall. Some details of questions were omitted such as sex differences and self-perceptions as they may give rise to preformed bias effects of the questionnaire. However, details of procedures and the roles and rights were specified before the participant could participate in the study. This stated information such as demographics (age/sex) would be collected and the study involved Likert scales, multiple choice questions and text boxes to gather data on facemasks e.g., period of usage. Additionally, pictures of faces would be presented, and the participant had to identify the most appropriate emotion for the face displayed.

Information also specified consent was given through the act of participation and submission of data, which was stated in the consent sheet (appendix B) with a reminder in the debriefing (appendix D) section before submission of results. This process of completing and submitting provided approval of consent. This was deemed appropriate as to reduce possible barriers of participating. Right to withdraw conditions were expressed to the individuals in the information, consent, and debriefing (appendix A, B and D) information as submission was taken as an act of approval of data usage and participants could not withdraw information after submitting as data would be anonymous. The debriefing (appendix D) provided supplementary links for participants to access if unforeseen distress was experienced from participation such as contact details of the researcher, HSE and NHS to reduce possible stress. Furthermore, precautions were taken to safeguard privacy by reducing personal details such as names, emails and place of work were not collected allowing anonymity. Data was recorded on google forms and then transferred to a excel file stored on an encrypted file on the researcher's laptop to safeguard participants data and be analyzed on SPSS.

Ethical Considerations

The National college of Ireland ethics committee approved this current experimental study. As it was suitable under ethical guidelines protecting participants rights for privacy by not collecting identifiable personal data and reducing any unforeseen harm as a residual from participating in the questionnaire through use of open contact to the researcher's email for further questions. Debriefing (appendix D) after participation in the questionnaire, access was provided to links for further supports to the HSE and NHS if required by a participant before submission of data.

Results

Descriptive Statistics

A total of 165 participants took part in the study. 67.3% of the sample identified as female (*n*=111), 31.5% identified as male (*n*=52) and 1.2% identified as other (*n*=2). Participants responded to questions identifying where they use facemasks; 67.3% of the sample identified workplace setting (*n*=111), 64.5% identified healthcare setting (*n*=106), 97% identified shopping (*n*=160),67.3% identified public transport (n=111), 1.2% outside public places (n=2) and 18.79% other (n=31). Additionally, identifying which key places use facemasks; 44.85% of the sample identified a medical theme (*n*=74), 21.82% identified customer environment (*n*=36), 12.12% identified other (*n*=20) and 21.21% identified public workplaces (*n*=35)(See Table 1).

Table 1

Frequencies for demographic variables (n=165)

Variable	Frequency	Valid%
Gender		
Female	111	67.3
Male	52	31.5
Other	2	1.2
Where they use facemasks		
Workplace Setting	111	67.3
Healthcare Setting	106	64.5
Shopping	160	97
Public Transport	111	67.3
Outside Public Places	2	1.2
Other	31	18.79
Key places use facemasks		
Medical Theme	74	44.85
Customer Environment	36	21.82
Other	20	12.12
Public Workplaces	35	21.21

Data recorded from the google forms questionnaire provided data for statistical analysis. Preliminary results indicated data was not normally distributed as all dependent scale variables violated Kolmogorov-Smirnov (Sig.<.05) tests meaning non-parametric tests were suggested for testing hypothesis 1 and 2.

Table 2

Descriptive statistics for Age, faces, masked, Total emotion accuracy.

Variable	n	*M*[95%CI]	SD	Range
Age	165	35.95[33.48,38.42]	16.05	18-79
Faces	165	5.12[4.86,5.39]	1.73	1-10
Masked	165	4.10[3.88,4.32]	1.43	1-9
Total Accuracy	165	9.23[8.84,9.62]	2.57	4-17

Inferential statistics

Hypothesis 1: If face masks are worn then emotional reading of facial expressions will become impaired. To examine the differences between individual's ability to accurately identify emotional expressions between faces and masked faces. A Wilcoxon Signed Rank Test showed that there was a statistically significant difference in emotion accuracy between masked versus unmasked faces; $z = -6.12$, $p < .001$ with a small effect size (r = .48) (Cohen 1988). The median score of accuracy showed a reduction from unmasked faces (Md=5) to masked faces (Md=4).

Hypothesis 2: If adults wear masks will this cause different reactions amongst gender interpretations of emotional expressions perceived. Due to insufficient sample size of 'other' category of sex these two responses were excluded, reducing the sample size valid for statistical analysis (N = 163). A Mann-Whitney U Test was performed it revealed no significant differences between males (*MD* = 9, *n* =52) and females (*MD* =9, *n* =111), U = 2822, z =-.230 , *p* =.818.

Hypothesis 3: Does peoples scores on a self-perception scale predict performance accuracy in classifying emotions. Preliminary analysis was conducted on the seven predictor variables and these were determined within acceptable ranges of homoscedasticity, normality in the P-Plots which was linear no violation of multicollinearity present in the data as all were in acceptable ranges. The scatter plot, outliers were outside the normal range [3.3,-3.3] Tabachnick, Fidell and Ullman (2007), however, data was accepted due to sample size affecting range. Correlations between predictor variables and criterion can be seen in (Table 3). One of seven predictor variables were significantly significant and negatively correlated (Q3 see table 3) r = -.15 with the criterion variable. The correlations between the predictor variables were also assessed with r values ranging from .30 to .46.

Table 3

Correlations between variables included in the model.

	Variable	1	2	3	4	5	6	7
1.	Total Emotion Accuracy	-						
2.	Q3 For how many hours in a day do you wear face masks?	-.15*	-					
3.	Q4 Do you find it difficult to communicate to others when wearing a face mask?	-.02	.06	-				
4.	Q5 When you are wearing a face mask do you think it is difficult for others to communicate with you?	-.04	.130*	.69***	-			
5.	Q7 Wearing a face mask has affected my ability to communicate?	.01	.09	.67***	.614***	-		
6.	Q8 Has wearing face masks effected the rate of miscommunication between you and others?	-.10	.128*	.57***	.58***	.59***	-	
7.	Q9 Has the wearing of face masks effected the quality of care you have received by others?	-.00	-.04	.38***	.30***	.46***	.38***	-
8.	Q10 Has wearing face masks effected the quality of care you provide to others?	.12	-.10	-.14*	-.22**	-.21**	-.134	-.06

Note: *p < .05; **p < .01; ***p < .001

Multiple regression analysis was conducted to determine how emotion accuracy scores could be affected by an individuals' self-perception (Q3, Q4, Q5, Q7, Q8, Q9, Q10) (Table 4). As no a priori hypotheses were conducted for the order of variables it was determined by order of question format for analysis. The seven predictor variables explained 5% of variance in Total emotion accuracy ($F(7,157) = 1.15$, $p = .335$). None of the seven variables indicated to predict Total emotion accuracy as all were non-significant (See Table 4).

Table 4

Multiple regression model predicting total emotion accuracy.

Variable	R^2	B	SE	β	*t*	*p*
1. Total Emotion Accuracy	**.05**					
2. Q3 For how many hours in a day do you wear face masks?		-.27	.16	-.14	-1.71	.090
3. Q4 Do you find it difficult to communicate to others when wearing a face mask?		.03	.64	.01	.05	.960
4. Q5 When you are wearing a face mask do you think it is difficult for others to communicate with you?		.03	.62	.12	.05	.958
5. Q7 Wearing a face mask has affected my ability to communicate?		.27	.26	-.141	1.01	.314
6. Q8 Has wearing face masks effected the rate of miscommunication between you and others?		-.29	.22	-.01	-1.34	.183
7. Q9 Has the wearing of face masks effected the quality of care you have received by others?		-.02	.21	.11	-.09	.927
8. Q10 Has wearing face masks effected the quality of care you provide to others?		.22	.15	1.52	1.41	.160

Note: **p<0.05

Summary

Overall, the results illustrated significant differences between faces and masked faces, highlighting masks negatively affect emotional accuracy in comparison to faces. Furthermore, no differences were located between gender and emotional recognition accuracy. By the process of regression analysis showed none of the seven predictor variables were able to significantly predict total emotion accuracy scores of individuals.

Discussion

This current study investigated ‘Do face masks impair facial emotional recognition’. This question was explored through three hypothesis comparing differences of participants between unmasked and masked faces, sex, and self-perception. Performance effects were explored in each hypothesis to produce the findings of this study.

Hypothesis 1: If face masks are worn then emotional reading of facial expressions will become impaired. Results were significant meaning the alternate hypothesis was accepted as differences were present between individuals ability to identify correctly emotional expressions on faces or masked. These results challenge previous results found by Carbon (2020) which suggested no differences. Possible explanations for these results may have been facemasks may inhibit information to a small effect size ($r = .48$) (Cohen, 1988) and a mean difference of 1 meaning individuals can identify emotional information in general, but facemasks can create small inaccuracies in emotion detection when only permitted information regarding a still image of a face. It is also possible due to higher prevalence of facemasks in the population aligning with (World Health Organization, 2020) public and government guidance; at the current time which may suggest the creation of errors in visual judgement as suggested by Spitzer (2020) as a possible issue however, further supporting evidence is required as these findings are novel in facemask research with emotions.

Hypothesis 2: If adults wear masks will this cause different reactions amongst gender interpretations of emotional expressions perceived. Results indicated sex differences were non-significant meaning the alternate hypothesis of females out-preforming males in emotional recognition was rejected and the null hypothesis was accepted as sex differences were not present. These may suggest females and males are equal in performance of emotional recognition challenging work by Thayer and Johnsen (2000) and supporting Carbon (2020) and Di Tella et al., (2020). As speed processing and eye gaze cueing effect (Alwall et al., 2010; Kirkland et al., 2013) for females maybe reduced as images were still and did not permit supplementary non-verbal cues as body language which may have helped both sexes perform differently (Schrage et al., 2020).

Hypothesis 3: Does peoples scores on a self-perception scale predict performance accuracy in classifying emotions. The results indicated no significant predictors of self-perception effecting emotional recognition of others faces overall. Meaning the alternate hypothesis of self-perceptions being able to shape emotion recognition accuracy scores for individuals was rejected and the null hypothesis of self-perceptions not influencing emotional recognition scores was accepted which supports Carbon (2020). Possible explanations for these results may be due to adaptive qualities of individuals performance was unaffected by mood or beliefs. As suggested by Ekman's (1992) theory "automatic appraisal" inferring detection of emotion is a rehearsed pattern reflex of an individual which may be reason for the results. Supported by Scarpina (2020) where fearful expression detection was expected to score higher amongst the time of Covid-19 however, there was no difference of speed comparison of neutral or fearful expressions. Scarpina et al. (2018) did suggest similar findings of possible emotions being harder to detect such as fear but no effect of confidence in ability changed facial emotion accuracy.

Other interesting findings for context of facemasks suggested key places individuals wore face masks the most common answer was shopping with 97% of the sample and the key workplace suggested to have facemasks present was in medical settings 44.85%. These results suggest to policy makers that confidence does not affect emotional perception of others influencing communication. Additionally, key places where masks are most common was shopping and medical settings which indicate individuals guidance adherence for use of facemasks by the World Health Organization (2020). Possible implications of this research suggest facemasks are inhibitory factor of emotional recognition. Further research into fabrics could alter visibility of facial features covered by facemasks suggest they provide more information of gestures to others improving communication (Atcherson et al., 2017) by use of different fabrics. Furthered by Corey, Jones, and Singer (2020) which studied the effects of acoustic interpretations influenced by facemasks finding direct contact to the speaker enabled optimal communication. However, an interesting finding was transparent facemasks slightly inhibited sound more than other face masks (Corey et al., 2020). Suggesting facemasks may reduce accuracy of verbal communication for individuals. Indicating further research on facemasks effects on communication is needed as facemasks can affect communication to a small extent either verbally or visually.

Limitations of this study are seen in the sample size as results are not normally distributed among participants as results were found using nonparametric alternatives. Additionally, internal consistency of questions was poor in range (Pallant, 2013), however, accepted as the study involved the same images for the Emotion recognition scale and the same answers for each emotional expression were used for comparison. Strengths of this study was the length of the questionnaire, its size, illustration, and colour prevented possible fatigue for individuals. It also allowed inner focus on contextual information into facemask usage such as areas where they are commonly present and self-perceptions of facemasks and

communication. These help to support research by Carbon (2020) showing findings relate in gender and self-perceptions having no significant effect on emotional recognition. However, this current research suggests reasons for further research, as facemasks showed to negatively decrease accuracy when identifying emotions which challenges Carbon's (2020) findings where there was no effect on accuracy rates due to face masks. The current research supports theories by Spitzer (2020) and Mehta et al., (2020) facemask usage showing small effects on emotional communication, which could be possibly explained by fatigue (Atangana & Atangana, 2020) caused by masks. Fear (Scarpina, 2020) detection reduction during the current time of Covid-19 and heightened aggression awareness (Di Tella et al., 2020; Carbon 2020) possibly causing errors in judgement. For these reasons, this research provides an important reference point for future research in this area of emotion research and communication.

It suggests future gaps in emotional states in context dependant settings which affect individuals and further understanding for health and care professions in terms of awareness of these possible factors and suggestions for future training in these areas. Possible areas for future study may explore mood states such as depression effecting interpretations of emotion displayed on others by using the images provided in the questionnaire (appendix C and F). By asking individuals to respond how the image makes them feel by rating personal preference and to choose out of the four options allowing comparability with accuracy. For further understanding of how perception information governs choice accuracy of facemask information. As research has suggested depression can affect interpretations in emotion recognition, as seen by Suslow, Junghanns and Arolt (2001) which found depressive symptomology affected reaction rates of individuals in emotion identification when categorising positive and negative faces yet, accuracy did not differ between individuals suffering from depression. Additionally, concurred by Leppänen, Milders, Bell, Terriere and

Hietanen (2004) where depression effected individuals ability of perceiving neutral faces accurately and slowed reaction times than those unaffected by depression. These were further challenged by Langenecker et al. (2005) were women suffering with depression had increased errors in accuracy than women not experiencing depression. Furthermore, supported by Carbon (2020) where individuals showed heightened arousal to negative stimuli which impaired accuracy rates on neutral stimuli in conditions tested with the use of facemasks. In this current time of Covid-19 and increased facemask usage it would be important for further understanding why the current results were significant and replicable in future studies. This research can be applied to retail, health, and social care as it suggests training in communication may be required to limit facemasks negative effects, which may aid individuals who may suffer from auditory or visual impairment as facemasks effect emotional interpretations. This information could support these people through advice on websites such as the World Health Organization (Blindness and vision impairment, 2021) or training.

Conclusion

The results from the current study suggest masks inhibit facial classification of emotions to a significant small effect in terms of accuracy challenging Carbon (2020) and supporting Spitzer (2020) which suggested facemasks could be presenting a challenge to communication. Additionally, sex and self-perceptions have no significant effect on individuals in identifying emotions on others supporting Carbon (2020). These findings indicate errors in perception of emotions can occur with facemasks on individuals. These are important for individuals to understand in roles of care and medical professions as errors could affect communication in these areas. This current research helps provide more contextual information regarding facemasks.

Constraints of this study was that it did not account for mood perceptions and internal consistency of questionnaire scales were poor (Pallant, 2013). Strengths of this study was the questions gathered contextual information during the time of Covid-19 when the prevalence of facemasks were high in the population. Additionally, it adds to the awareness of possible side effects of facemasks in a social aspect of emotion detection which has been theorised by Spitzer (2020), Mehta et al., (2020) and applied by Carbon (2020). Previous research with facemasks has focused on protective features (Fadare & Okoffo, 2020; Alenezi et al., 2020) and linguistics (Atcherson et al., 2017). Future research could investigate facemasks effect on emotional recognition with mood perceptions e.g., anxiety or depression. These may alter interpretations as seen in previous research (Leppänen et al., 2004; Langenecker et al., 2005; Elliot et al., 2014) of individuals suffering from depression.

This research has highlighted social issues for the practises of facemasks in response to emotion recognition. Applications of this research can be utilised as a reference point for future research or policy adaptations such as training and awareness. These could be applied and benefit many social and medical settings within the community.

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Appendices

Appendix A

Participant Information
Do face masks impair facial emotional recognition?

Before choosing to become involved in this voluntary study please read the information provided on the background of this research and what is involved and how it will work and what it means to take part in this study.

What is this study about?

My name is Luke Clarke, I am a 3rd year Psychology student in the BA in Psychology program studying in the National College of Ireland. As part of our degree, we must carry out an independent research project.

What will this study involve?

Using a questionnaire, I want to investigate the effects of face masks on people's ability to recognise emotional expressions on faces that are partially covered. There is 36 Questions in total some are in relation to personal information and the effect face masks has on communication. There will be one example image before proceeding to the images with emotional expressions on faces then onto masked faces.

There will be text boxes to fill in information and numbered scales where you choose the appropriate one as a response.

The questionnaire will ask you to identify the correct word to the facial expressions shown. There will be a multiple choice of four words for each face, you will be asked to circle the correct emotion for each face.

You may change your choice by selecting a different option choosing the correct one.
The questionnaire will take approximately 9-16 minutes but is not time sensitive.

!! Warning !!

Participants will **not** be **permitted to reuse, distribute, further disseminate, or copy any images** within the study as it is not permitted by the researcher or by the MPI faces database all access to these are strictly prohibited. It is mandatory that by participation you agree a disclaimer that you do not have the right to any of these images.

Who can take part?

People aged between 18-85 years old that are willing to volunteer with the ability to understand and read English.

It may help the participant understand emotional expressions and be able to interpret the faces and words however, not required.

What are the benefits and drawbacks of volunteering?

There will be no incentive for participating in this experiment other than the satisfaction of helping improve academic understanding of this research area. As participation is completely voluntary, and participants have the right to refuse to answer questions and withdraw from this study at any time prior to submission of the online questionnaire without any negative consequences.

There is minimal to no risk that images cause distress for participants.

If distress is experienced contact the researcher, for questions, clarification and feel free to withdraw at any time until submission, where supports services will be provided if needed.

What will happen to my collected data?

The questionnaire is anonymous; the participants privacy will be protected as no identifiable information will be collected. Also, only the researcher and the supervisor at the National College of Ireland will have access to information from the research project. The de-identified data will be stored on a password protected file on the researcher's computer for 5 years, in accordance with the NCI data retention policy.

What if I begin the questionnaire and I wish to withdraw?

Participants can withdraw by leaving the questionnaire once opened online by closing the window and not filling in the questionnaire this will be taken as an acknowledgement that they do not wish to participate. However, once submitted they will be unable to withdraw information as it will be made de-identifiable. There will be no penalty for withdrawing.

What will happen with the results?

The results of this study will be presented in my 3rd year study and submitted to the National College of Ireland.

This study is for research purposes and does not make any suggestions about the use of face masks or public health protection. Any further information can be found on the HSE website regarding face masks and health advice provide by the HSE,NHS or WHO websites provided below:

HSE: https://www2.hse.ie/coronavirus/

WHO: https://www.who.int/health-topics/coronavirus#tab=tab_1

NHS: https://www.nhs.uk/conditions/coronavirus-covid-19/

Contact details.

If you would like to participate in this experiment to understand the effects face masks on emotional interpreting facial expressions, please contact me on my email:

facemasksandmoodrecognition@gmail.com

Appendix B

Consent Information

Project title: Do face masks impair facial emotional recognition?

Researcher: Luke Clarke

If there are any questions you want further explanation before participating in the study, please contact the researcher to provide you with any additional information. Consent information and rights to data usage is given by the participants by the submission of responses at the end of the questionnaire. The only personal data collected will be in relations to age and identification of gender.

If a participant feels uncomfortable during this study, you have the right to withdraw with no negative consequences.

Additionally, personal data will be strictly confidential in accordance with data protection act 1988-2018 and that you under the Freedom of information legislation entitles you to information regarding the usage of data collected.

A Reminder

By reading the above information and participation you agree to informed consent, to allow your data to be used for the purposes of research and that you will not copy, redistribute, or disseminate any of the images used within this questionnaire.

There will be questions where text will be needed and additionally optional scales where you choose your appropriate choice to the statement above.

To pick an answer please click the circle appropriate and to change your answer click the appropriate circle.

To withdraw from this research please close the window and do not fill in the rest of the questionnaire.

If there are any questions or issues, please contact the researcher by the email provided :

facemasksandmoodrecognition@gmail.com

Appendix C

Questionnaire

Q1 What age are you? (If under 18 years old please exit the questionnaire)

Q2 What is your gender?

- **Female**
- **Male**
- **Other**
- **Prefer not to say.**

Q3 For how many hours in a day do you wear face masks?

- **0**
- **Less than 1 hour**
- **1 – 2**
- **3 – 4**
- **4 hours or more**

Q4 Do you find it difficult to communicate to others when wearing a face mask?

- **Yes**
- **No**

Q5 When you are wearing a face mask do you think it is difficult for others to communicate with you?

- **Yes**
- **No**

Q6 Are there any key workplaces where you think face masks are required?

Q7 Wearing a face mask has affected my ability to communicate?

Strongly Disagree 1 2 3 4 5 Strongly Agree

Q8 Has wearing face masks effected the rate of miscommunication between you and others?

Very Rarely 1 2 3 4 5 Very Often

Q9 Has the wearing of face masks effected the quality of care you have received by others?

Very Rarely 1 2 3 4 5 Very Often

Q10 Has wearing face masks effected the quality of care you provide to others?

Strongly Agree 1 2 3 4 5 Strongly Disagree

Q11 Where do you use face masks? (you can pick multiple answers)

- **Workplace setting**
- **Healthcare setting**
- **Shopping**
- **When on public transport**
- **Other(add in)**

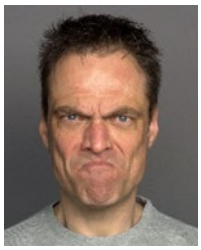
Q12 Example question what is the 'emotion' shown in this face?

- **Smiling**
- **Sad**
- **Joyful**
- **Neutral**

Full Faces Part 1

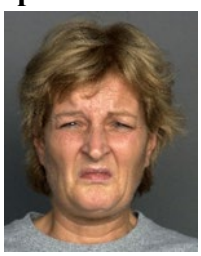
These twelve images you are asked to identify the correct emotional face expression shown.

Q13 What emotional expression is shown on the face below?



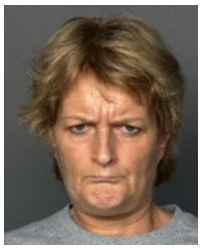
- **Bored**
- **Anger**
- **Furious**
- **Stern**

Q14 What emotional expression is shown on the face below?



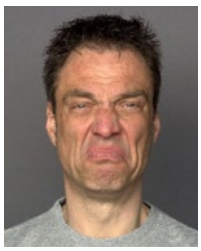
- **Disgust**
- **Bitter**
- **Tired**
- **Sour**

Q15 What emotional expression is shown on the face below?



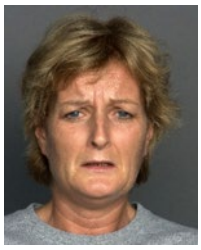
- **Cross**
- **Upset**
- **Anger**
- **Frowning**

Q16 What emotional expression is shown on the face below?



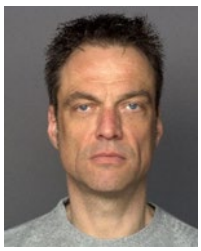
- **Upset**
- **Sad**
- **Dread**
- **Disgust**

Q17 What emotional expression is shown on the face below?



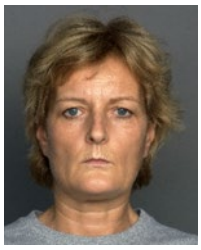
- **Sad**
- **Fear**
- **Disappointed**
- **Shame**

Q18 What emotional expression is shown on the face below?



- **Unenthusiastic**
- **Bored**
- **Neutral**
- **Cold**

Q19 What emotional expression is shown on the face below?



- **Angry**
- **Neutral**
- **Stern**
- **Cross**

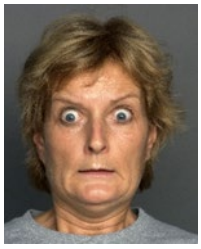
Q20 What emotional expression is shown on the face below?

- **Fear**
- **Surprise**
- **Shocked**
- **Stunned**

Q21 What emotional expression is shown on the face below?

- **Joyful**
- **Cheerful**
- **Happy**
- **Merry**

Q22 What emotional expression is shown on the face below?

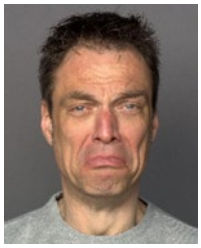


- **Surprise**
- **Fear**
- **Terror**
- **Panic**

Q23 What emotional expression is shown on the face below?

- **Jolly**
- **Happy**
- **Merry**
- **Smiling**

Q24 What emotional expression is shown on the face below?



- **Sad**
- **Scared**
- **Upset**
- **Miserable**

Faces with masks Part 2.

These next twelve images you are asked to identify the correct emotional face expression shown.

Q25 What emotional expression is shown on the face below?

- **Dissatisfied**
- **Angry**
- **Bored**
- **Neutral**

Q26 What emotional expression is shown on the face below?

- **Furious**
- **Stern**
- **Angry**
- **Disapproving**

Q27 What emotional expression is shown on the face below?

- **Cheerful**
- **Merry**
- **Joyful**
- **Happy**

Q28 What emotional expression is shown on the face below?

- **Happy**
- **Disgust**
- **Angry**
- **Upset**

Q29 What emotional expression is shown on the face below?

- **Shocked**
- **Surprise**
- **Fear**
- **Terror**

Q30 What emotional expression is shown on the face below?

- **Sad**
- **Upset**
- **Disappointed**
- **Disgust**

Q31 What emotional expression is shown on the face below?

- **Terror**
- **Surprise**
- **Fear**
- **Shock**

Q32 What emotional expression is shown on the face below?

- **Disgust**
- **Happy**
- **Joyful**
- **Smiling**

Q33 What emotional expression is shown on the face below?

- **Neutral**
- **Bored**
- **Tired**
- **Dissatisfied**

Q34 What emotional expression is shown on the face below?

- **Upset**
- **Scared**
- **Disgust**
- **Terror**

Q35 What emotional expression is shown on the face below?

- **Sad**
- **Discomfort**
- **Bored**
- **Dissatisfied**

Q36 What emotional expression is shown on the face below?

- **Furious**
- **Cross**
- **Stern**
- **Angry**

Appendix D

Debriefing

The researcher would like to thank all participants for contributions to this research which will provide a detailed understanding of effects of facemasks on emotional recognition.

The participant has the right to withdraw up until the submission of results. After the completion and submission, the participant has no ability to withdraw data as it will be anonymous. As participation through the questionnaire the participant allows access to use data for research and provides informed consent through submission of data.

It is the responsibility of the researcher to protect participants and minimise any effects of harm that may fall on the participant should they arise.

If any adverse effects create discomfort to you, in relation to the questionnaire, please inform the researcher. As you cannot recall your submission of data as it has been made anonymous. However, the researcher can review and evaluate concerns raised to minimise potential risk to other participants.

Researchers email: facemasksandmoodrecognition@gmail.com

Follow these below links if any unlisted symptoms effects arise.

Aware (for help with depression bipolar or mood disorders) Free helpline open mon-Sunday 10am-10pm Tel:1800 80 48 48

Samaritans : 116 123 or text YMH 086 1800 280 (messaging support service)

Jigsaw helps young and adult people looking for mental health support and advice Tel: 1800 jigsaw(544 729)

Advice for public health guidance will be provided by emails below.

HSE: https://www2.hse.ie/coronavirus/

WHO: https://www.who.int/health-topics/coronavirus#tab=tab_1

NHS: https://www.nhs.uk/conditions/coronavirus-covid-19/

Confirmation message

Thank you for your participation your responses have been recorded and will be made anonymous from this point on.

Appendix E

Evidence of data analysis

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of TotalscoresforAccuracy is the same across categories of Sex.	Independent-Samples Mann-Whitney U Test	.818	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .050.

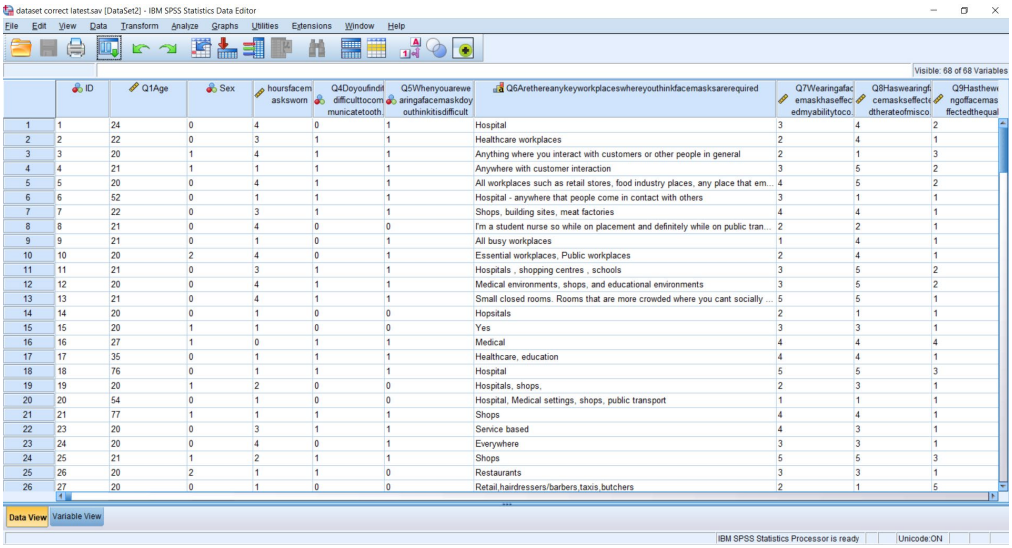
Independent-Samples Mann-Whitney U Test

TotalscoresforAccuracy across Sex

Independent-Samples Mann-Whitney U Test Summary

Total N	163
Mann-Whitney U	2822.000
Wilcoxon W	4200.000
Test Statistic	2822.000
Standard Error	278.411
Standardized Test Statistic	-.230
Asymptotic Sig.(2-sided test)	.818

Data file



Appendix F

Key for MPI Faces					
Anger	Disgust	Fear	Happiness	Neutrality	Sadness