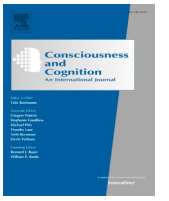
Consciousness and Cognition 109 (2023) 103480

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog



Review article

Strange face illusions: A systematic review and quality analysis

Joanna Mash [a,*], Paul M. Jenkinson [a,b], Charlotte E. Dean [a], Keith R. Laws [a]

[a] School of Life and Medical Sciences, University of Hertfordshire, Hatfield, UK
[b] ISN Psychology, Institute for Social Neuroscience, Melbourne, Australia

ARTICLE INFO

Keywords:
Illusions
Anomalous subjective experiences
Dissociation
Mirror gazing
Perceptual distortion

ABSTRACT

Background: Strange face illusions describe a range of visual apparitions that occur when an observer gazes at their image reflected in a mirror or at another person's face in a dimly lit room. The illusory effects range from mild alterations in colour, or contrast, to the perception of distorted facial features, or new strange faces. The current review critically evaluates studies investigating strange face illusions, their methodological quality, and existing interpretations.
Method: Searches conducted using Scopus, PubMed, ScienceDirect and the grey literature until June 2022 identified 21 studies (N = 1,132; healthy participants n = 1,042; clinical participants n = 90) meeting the inclusion criteria (i.e., providing new empirical evidence relating to strange face illusions). The total sample had a mean age of 28.3 years (SD = 10.31) and two thirds (67 %) of participants tested to date are female. Results are reported using the Preferred Reporting Items for Systematic Reviews and meta-Analyses (PRISMA) guidelines. The review was preregistered at the Open Science Framework (OSF: https://osf.io/ek48d).
Results: Pooling data across studies, illusory new strange faces are experienced by 58% (95%CI 48 to 68) of nonclinical participants. Study quality as assessed by the Appraisal Tool for Cross-Sectional Studies (AXIS) revealed that 3/21 (14.28%) studies were rated as high, 9/21 (42.86%) as moderate and 9/21 (42.86%) as low quality. Whilst the items relating specifically to reporting quality scored quite highly, those relating to study design and possible biases were lower and more variable. Overall, study quality accounted for 87% of the variance in reporting rates for strange faces, with higher quality being associated with lower illusion rates. The prevalence of illusions was also significantly greater in samples that were older, had higher proportions of female participants and for the interpersonal dyad (IGDT) compared to the mirror gaze paradigm (MGT). The moderating impact of study quality persisted in a multiple *meta*-regression involving participant age, paradigm type (IGDT vs MGT) and level of feature distortion. Our review point to the importance of reduced light levels, face stimuli and prolonged eye fixation for strange face illusions to emerge.
Conclusion: Strange face illusions reliably occur in both mirror-gazing and interpersonal gazing dyad paradigms. Further research of higher quality is required to establish the prevalence and particularly, the mechanisms underpinning strange face illusions.

1. Introduction

Strange face illusions (SFIs) describe a range of face-related visual apparitions, which may occur when one observes a face in a

* Corresponding author.
E-mail address: j.mash@herts.ac.uk (J. Mash).

https://doi.org/10.1016/j.concog.2023.103480
Received 3 December 2021; Received in revised form 27 January 2023; Accepted 28 January 2023
Available online 8 February 2023

dimly lit room. In contrast to most illusion-inducing paradigms, the strange face illusion paradigm induces a variety of illusions. Reported experiences range from small changes in luminance, colour, and contrast, to distorted facial features, and through to the perception of completely new strange faces. The latter may involve faces of relatives, familiar faces, and unfamiliar faces, but extends even to monstrous faces and animal faces. In the original strange face illusion study (Caputo, 2010a), using a sample of 50 healthy individuals, it was reported that 66 % saw distorted facial features, 18 % a parent's face, 28 % an unknown person, 28 % archetypal faces, 18 % an animal face and 48 % monstrous/fantastical faces. The diversity and complexity of illusions induced by this simple paradigm appears to make it somewhat unique.

1.1. *Strange face illusion induction techniques*

Induction of SFIs have been reported using two main methodologies:

Fig. 1(A), involves a seated participant, positioned approximately 0.4 m from a standard, frontal plane mirror positioned at eye-level. (Brewin & Mersaditabari, 2013; Brewin et al., 2013; Caputo, 2010a, b, 2011, 2016; Caputo et al., 2012, 2014; Demartini et al., 2020; Derome et al., 2018, 2022; Fonseca-Pedrero et al., 2015; Nistico et al., 2020; Pick et al., 2020; Rugens & Terhune, 2013; Shin et al., 2019). A variation of the MGT was conducted using a split-mirror made up of two mirrors, measuring 0.2 m by 0.4 m, which were mounted side-by-side with a 4 mm gap between them (Caputo, 2021). A light source which contains a 10 – 25 Watt halogen light bulb is placed on the floor (~1m) behind the participant. Illusions have been reliably reported with illumination levels of "around 0.6–1 lx" (Caputo et al., 2020, p12) however some studies recommend empirically measuring lux at the face, with 0.8 lx being proposed to be an optimum level for maximum illusion induction. Some minor variations in the precise procedure and experimental set-up of the MGT are apparent across studies. For example, not all studies have assessed the lux levels at the face (Brewin & Colson 2013; Brewin & Mersaditabari, 2013; Pick et al., 2020; Rugens & Terhune, 2013; Shin et al., 2019; Fonseca-Pedrero et al., 2015; Derome et al., 2018; Derome et al., 2022).

The interpersonal gazing dyad task (IGDT), Fig. 1(B), typically follows the same general set-up of the MGT but involves two participants sitting 0.4 m apart (~1m between faces) rather than a single participant viewing themselves in a mirror. A light source positioned between the participants under a flat opaque panel which is fixed to the chairs. It is recommended that illumination at the face is empirically measured to a value of 0.2 cd m^{-2} or 0.8 lx (Caputo, 2013, 2015, 2017, 2019).

In both the MGT and IGDT, participants are instructed to fixate on the eyes of the observed face. For example: participant instructions taken from an exemplar MGT study and an exemplar IGDT study are respectively: "Your task is to look at your face in the mirror. You should keep staring into your eyes. The task will last seven minutes" (Caputo et al., 2014, p.2) and "You should maintain a neutral facial expression. Your task is to look at the other participant; you should keep staring into the eyes of the other participant, the session will last 10 min" (Caputo, 2015, p.660). Typically, the mirror-gaze session lasts for either 10 min (Brewin et al., 2013; Brewin & Mersaditabari, 2013; Caputo, 2010a, b, 2011, 2016; Demartini et al., 2020; Derome et al., 2018, 2022; Fonseca-Pedrero et al., 2015; Nisticò et al., 2020; Pick et al., 2020; Shin et al., 2019), 11 min (Rugens & Terhune, 2013) or 7 min (Caputo et al., 2012, 2014). IGDT sessions typically last 10 min (Caputo, 2013, 2015, 2017, 2019).

The characteristics of paradigm involve a combination of environmental and behavioural manipulations, yet the factors that combine to elicit illusory faces have not been established nor much discussed to date; and perceptual explanations of strange faces that are grounded within a cognitive neuroscience/psychology framework, are somewhat lacking. As a result, some researchers propose that such "anomalous experiences suggest mechanisms beyond perceptual distortions or illusions" (Caputo et al., 2020) and represent a psychological illusion, in the form of projected dissociative identities. Such psychodynamic interpretations stem from the fact that this paradigm also induces dissociation, though the degree of evidence to support this interpretation is unclear. Moreover, studies have examined strange face illusions in various clinical groups, revealing some interesting associations between pathology and proneness to strange faces. Consolidating our understanding of SFIs is important because they may potentially provide novel insights into perception and cognition, which may be particularly relevant to some clinical groups.

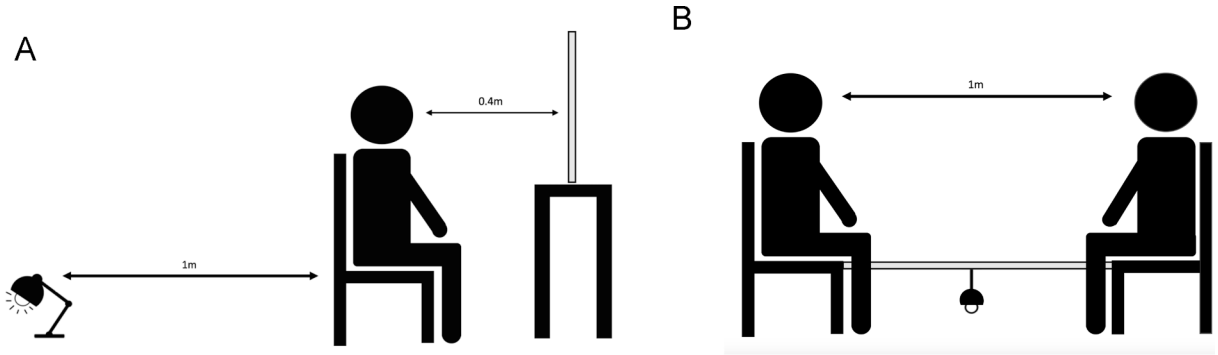


Fig 1. Experimental set-up. (A) The Mirror Gaze Task (MGT) and (B) The Inter-personal Gazing Dyad Task (IGDT).

1.2. Rationale for the review

The strange face illusion first emerged over a decade ago and a substantial number of studies have now examined this curious phenomenon in samples derived from the general population and various clinical groups. The current review aims to provide a synthesis and evaluation of the strange face illusion literature, with a particular focus on the following questions:

(1) What is the methodological quality of strange face illusion studies?
(2) How are strange face illusions defined and categorized?
(3) What measures are used to capture strange face illusions?
(4) What key factors influence strange face illusion induction?
(5) What associations have been identified (e.g., between strange face illusions and dissociation or in relation to clinical groups).
(6) What explanations and interpretations are proposed to account for strange face illusions?

2. Method

This systematic review was preregistered on the Open Science Framework (OSF: https://osf.io/ek48d) in November 2020 and followed the Preferred Reporting Items for Systematic Reviews and meta-Analyses guidelines (PRISMA) (Page et al., 2021).

2.1. Identification of studies

Studies were identified by searching Scopus, PubMed and ScienceDirect and the grey literature (OpenGrey, PsyRxiv, BioRxiv) up to June 2022. Abstract, title, and key words of articles were searched using the following search terms:

1) "Strange face illusion"
2) "Caputo" AND "strange face"
3) "mirror gazing" AND "illusion"
4) "dissociation" AND "mirror gazing".

No search limits were applied to date of publication, but only papers in the English language were searched. For each paper identified as relevant, any articles citing the paper were further assessed for inclusion using the 'cited by' function of each online database. The references of identified studies were also inspected for any further relevant studies.

2.2. Inclusion and exclusion criteria

Studies were included if they provided original data relating to the 'Strange face illusion', using any experimental paradigm. Studies were excluded if they: 1) investigated illusions in the domain of parapsychology, such as psychomanteums; or 2) focussed on psychiatric or neurological patients with abnormal face perceptions arising from known face-related psychopathologies (e.g., mirror agnosia, prosopagnosia, Capgras delusion).

2.3. Selection process

Independent searches were conducted by two authors (J.M & K.L). Screening and selection of relevant articles were conducted by J. M. Where the titles of articles appeared relevant, abstracts were screened for eligibility, and full texts of potentially eligible studies were retrieved.

2.4. Data extraction protocol

The following information was extracted from each paper: year of publication, study design, experimental paradigm, control group, target group, number of participants, aim, mean age, outcome measures (e.g., response button, free text descriptions or verbal reports, structured questionnaires, or tasks) and key findings. Where data were unavailable or unclear, we contacted the authors and received clarification.

2.5. Synthesis of results

Studies were grouped by their aims into validity studies (i.e., investigating phenomenology, methodologies, and mechanisms); those using strange face illusions as a tool for dissociation induction; those involving clinical groups; and studies focussing on associations. Any information relating to prevalence of illusions (i.e., reported data in either the results or comments made in the text) was tabulated for synthesis and subsequent analysis. If prevalence of illusions were not reported, where possible, this data was calculated from any relevant data provided or inferred from any relevant comments in the text. An exploratory subgroup analysis was conducted to explore any heterogeneity in prevalence of illusions across studies that used different induction methodologies, and univariate *meta*-regression analyses were conducted using the Method of Moments approach, which allows the estimation of population parameters.

Although no definitive minimum number of studies is required for *meta*-regression, we follow the Cochrane Handbook recommendation of at least 10 studies for moderators that are a continuous variable (Higgins et al., 2019); and for a categorical subgroup variable, a minimum of 4 studies per group (Higgins et al., 2019; Fu et al., 2011).

2.6. Quality assessment

A quality assessment was conducted on the selected studies using the Appraisal Tool for Cross-Sectional Studies (AXIS) (Downes et al., 2016) which is a checklist tool developed to assess quality for cross-sectional studies. The AXIS contains 20 items that assess reporting quality, study design and possible risk of bias. Seven questions assess reporting quality (items: 1, 4, 10, 11, 12, 16 and 18), seven relate to study design quality (items: 2, 3, 5, 8, 17, 19 and 20) and six to possible biases in the study (items: 6, 7, 9, 13, 14 and 15). Each study was rated independently by two authors (JM and CD). Where discrepancies occurred between raters, these were discussed, and a final rating agreed upon.

3. Results

A summary of the search and selection process is shown in Fig. 2. Excluded studies are listed in Supplementary Materials.

Twenty-one published articles (total N = 1,132; healthy n = 1,042; clinical participants n = 90) met inclusion criteria, see Table 1. The total sample had a mean age of 28.3 years (SD = 10.31) and two thirds (67 %) of all participants tested to date are female. Searches of the grey literature did not yield any results.Five studies focussed on illusion validity, including phenomenology, methodology and mechanisms (Caputo, 2010a, b, 2011, 2013, 2021). Four studies assessed clinical groups (Caputo et al., 2012, 2014; Demartini et al., 2020; Nisticò et al., 2020). Three prodromal studies investigated the relationship between SFIs and schizotypal personality traits in healthy adolescents (Derome et al., 2018, 2022; Fonseca-Pedrero et al., 2015). Four studies focussed on associations between SFIs and empathy (Caputo, 2016), spirituality (Caputo, 2017) and dissociative experiences (Caputo, 2015, 2019). Five studies used the mirror-gazing task as a method to induce dissociation (Brewin et al., 2013; Brewin & Mersaditabari, 2013; Pick et al., 2020; Rugens & Terhune, 2013; Shin et al., 2019).

3.1. Quality assessment

The AXIS quality assessment ratings for individual studies are shown in Supplementary Materials. The two raters (JM and CD) agreed on 403/416 ratings, giving 'almost perfect' agreement (97 %) with Kappa = 0.94. Although the 20 AXIS items are not equally weighted, the mean score was 12.10 (SD = 3.70) and scores for studies ranged from 2 to 19. Following recent research (Antczak et al., 2020), we classified AXIS quality scores according to the number of "Yes" responses for the 20 items for each study – so, studies

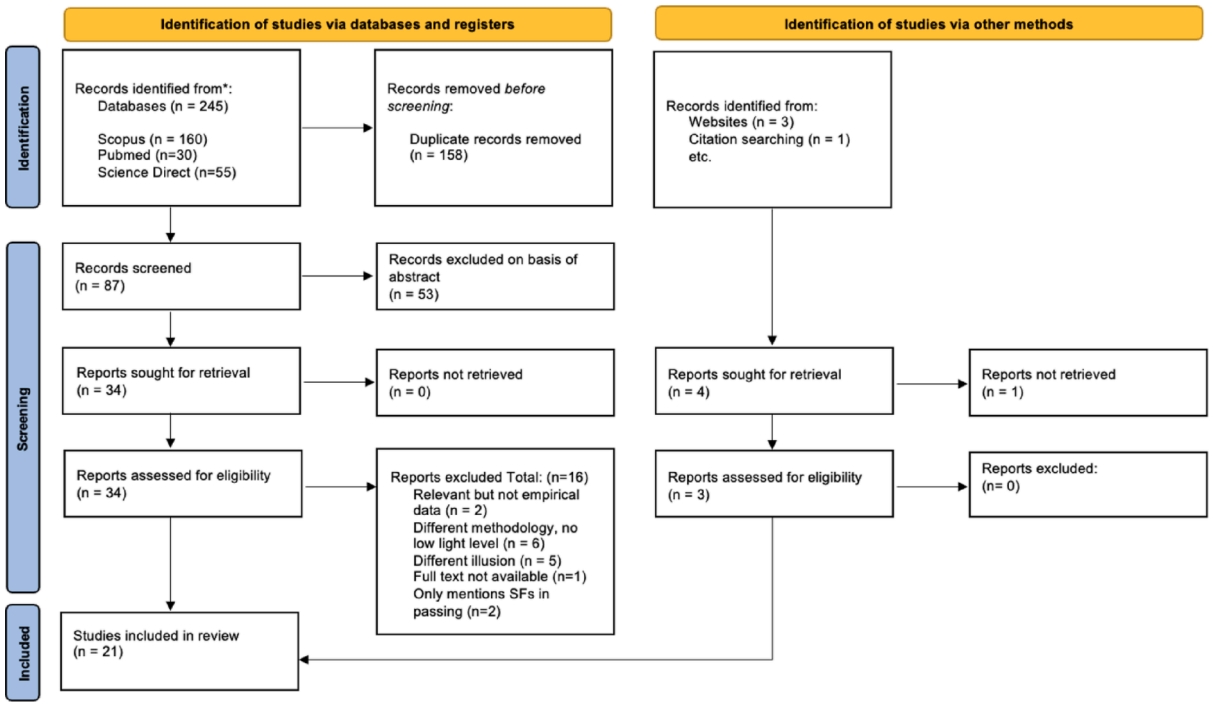


Fig 2. PRISMA Flow chart.

Table 1
Studies included in the review.

Study	Sample size	Mean Age Years (SD)	Gender M:F	Type	Paradigm	Aim	Outcome	Key findings
Caputo (2010a)	N = 50	23 (2.1)	No information provided	Validity	MGT	The effects of mild sensory deprivation on perception	Free text.	Different face-related illusions reported including feature distortions, parent, unknown person, and animal faces.
Caputo (2010b)	Exp 1 (n = 20) Exp 2 (n = 14) Exp 3 (n = 8)	23 (2.2)	4:16 4:10 2:6	Validity	MGT	Exp 1: Frequency of all illusions. Exp 2: Frequency of strange face illusions only. Exp 3: Effect of light level.	Response button. Free text.	Lower illumination leads to more illusions. Higher illumination leads to longer time-to-onset of illusions.
Caputo (2011)	N = 7	44 to 49	4:3	Validity	MGT	If participants would attribute life to an inanimate mask (i.e., see illusions).	Response button. Free text.	Face related illusions occur when using masks.
Caputo et al. (2012)	Schizophrenia patients (n = 16) Healthy controls (n = 21)	44.3 (13.4) 38.1 (11.8)	5:11 6:15	Clinical group	MGT	A comparison of strange face illusions between schizophrenia patients and healthy controls.	Response button Positive and negative syndrome scale. Cardiff anomalous perception scale (CAPS). Mirror-gaze interview	Schizophrenia patients demonstrate more frequent illusions, more types of illusions, stronger illusions and believe them to be more real than controls. No relationship between illusions and CAPS.
Caputo (2013)	N = 10 Exp (fixate on eyes: n = 8) Healthy controls (fixate on body: n = 2)	27.3 (8.6)	2:8	Validity	IGDT	Do strange face illusions occur in inter-subject gazing?	Response button. Questionnaire to categorise phenomena in archetypal groups.	Duration and frequency of illusions in dyads are similar to mirror gazing. Inter-subjective synchronisation of illusions: mean synchrony across all participants was 39 % +/- 11. Synchrony was statistically significant in 50 % of participants. Number of illusions is higher in dyads.
Brewin & Mersaditabari (2013)	Exp (n = 40) Healthy controls (n = 20)	25.4 (2.0)	12:48	Dissociation induction	MGT	Investigates effect of dissociation on visual memory.	Rey-Osterrieth complex figure test. Clinically Administered Dissociative States Scale (CADSS).	Dissociation impairs visual memory.
Brewin et al. (2013)	Exp 1: mirror gazing group (n = 45) Healthy controls (n = 15) Exp 2: (Story recall) (n = 40)	20.1 (1.6)	19:41 5:35	Dissociation induction	MGT	To induce dissociation & investigate its influence on cognition (i.e., time estimation, digit and spatial span, story recall)	CADSS. Time estimation task. Perceptual attention task (i.e., feature matching). Digit span and spatial span. Dissociative experiences scale. Short (verbal) mirror gaze questionnaire. Positive and negative affect schedule. Wechsler memory	Dissociation impairs some aspects of memory (digit span, spatial span, and story recall) and time perception, but perceptual attention, spatial span and immediate recall unaffected

(*continued on next page*)

Table 1 (*continued*)

Study	Sample size	Mean Age Years (SD)	Gender M:F	Type	Paradigm	Aim	Outcome	Key findings
							scale.	
Rugens & Terhune (2013)	Guilt primed (n = 16) Negative primed (n = 16) Neutral control (n = 17)	28.4 (9.4)	10:40	Dissociation induction	MGT	Investigates influence of guilt on relationship between dissociative tendencies and state dissociation	Dissociative Experiences Scale. Sentence completion task. Peritraumatic dissociative experiences questionnaire.	Dissociative tendencies correlated with state dissociation following guilt primes, but not after negative or neutral primes. This suggests that guilt augments the relationship between dissociative tendencies and state dissociation.
Caputo et al. (2014)	Depressed patients (n = 13) Healthy controls (n = 13)	50 (14.2) 40.2 (13)	5:8 5:8	Clinical group	MGT	Comparison of strange face illusions in depressed patients and healthy controls	Mirror gaze interview.	Depressed patients less likely to see face illusions and when they do, they occur less frequently, have shorter duration, and have fewer types of strange faces than healthy controls. Depressed patients typically only perceive mild feature distortions (i.e., faint changes).
Caputo (2015)	Dissociation group (facing each other) (n = 20) Controls (sitting next to each other) (n = 20)	21.9 (1.3)	10:30	Associations	IGDT	The relationship between SF illusions, dissociation, and face dysmorphia.	CADSS Strange Face Questionnaire (SFQ) Dysmorphic face scale	No association between dissociation and illusions. Illusions occur in dyads therefore strange face illusions are not specific to mirrors. Illusions were not associated with higher levels of face dysmorphia. Higher dissociation scores in inter-personal gazing dyads compared to mirror gazing.
Fonseca-Pedrero et al. (2015)	Healthy adolescents: post hoc groups defined as: slight change in light/ colour (n = 22), own face deformation (n = 50), vision (other facial identity) (n = 30), non-human vision (n = 8).	16.3 (1.8)	59:51	Prodromal	MGT	The relationship between schizotypy and strange face illusions in healthy adolescents.	Response button. Schizotypal personality questionnaire. A variation of the SFQ	SF illusions more frequent in individuals high on schizotypal traits. Frequency and time-to-onset of strange face illusions significantly related to schizotypy disorganised domain.
Caputo (2016)	N = 15	23.7 (5.4)	6:9	Associations	MGT	The relationship between empathetic personality traits and strange face illusions	Free-text description of strange face illusions Interpersonal reactivity index.	Illusions significantly correlated with fantasy & empathetic-concern subscales. Interpreted as strange face illusions being related to vulnerability to contagion, mimicry & cognitive empathy

(*continued on next page*)

Table 1 (*continued*)

Study	Sample size	Mean Age Years (SD)	Gender M:F	Type	Paradigm	Aim	Outcome	Key findings
Caputo (2017)	N = 30	21.7 (1.2)	6:24	Associations	IGDT	The relationship between strange face illusions and personality differences in spirituality and superstition.	Spiritual transcendence scale. Paranormal beliefs scale. SFQ.	Illusions not associated with paranormal beliefs. Only the 'universality' subscale of the spiritual transcendence scale correlated with illusions.
Derome et al. (2018)	Non-clinical adolescents Time 1: N = 75 strange face illusion group i.e., other facial identities, (n = 23) + non-human vision, (n = 7). controls i.e., feature distortions only group (n = 25) no illusions / light, colour, contrast changes only, (n = 20) Time 2: N = 39	16.9 (2.5)	39:36	Prodromal	MGT	To characterize how connectivity in resting state networks differ in adolescents who do and do not report strange face illusions.	Response button fMRI Schizotypal personality questionnaire. Adult self-report. Youth self-report. Mirror-gaze questionnaire	Functional connectivity during a resting state differed in adolescents who saw strange face illusions vs those who saw only feature distortions. Strange face illusion group showed decreased within-network connectivity in right fusiform gyrus and superior parietal lobule; and greater co-activation of the dorsal default mode network in the left middle occipital gyrus. Suggests a subtle difference in resting state connectivity networks of non-clinical adolescents who experience strange face illusions.
Caputo (2019)	N = 90	22 (2.3)	29:61	Associations	IGDT	The relationship between dissociation and strange face illusions.	CADSS SFQ Artistic impressions of strange face illusions	Dissociation and illusions correlated. Proposed that different types of strange face illusions can be differentiated using the CADSS subscales
Shin et al. (2019)	N = 50 Dissociation group (n = 25) Healthy controls (n = 25)	23 (6) 24 (6)	5:45	Dissociation induction	MGT	The effect of dissociation on emotional responsivity	Positive and negative affect scale. CADSS. Self-assessment manikin. National reading test. Weschler memory scale III.	Dissociation group rated negative and neutral stimuli as significantly less unpleasant than controls, which suggests that dissociative states provide short term emotional numbing of negative affect.
Nisticò et al. (2020)	Psychogenic non-epileptic seizure patients (n = 11) Functional movement disorder patients (n = 17) Healthy controls (n = 18)	36.1 (16.8) 43.6 (16.1) 38.1 (13.8)	0:11 4:14 3:14	Clinical group	MGT	To assess strange face illusions in relation to dissociation in these clinical groups which are proposed to fall on a continuum related to dissociation.	SFQ An ad-hoc questionnaire assessing anomalous sensation. A variation of the CADSS.	Psychogenic non-epileptic seizure patients and functional movement disorder patients scored higher on the CADSS than healthy controls but no difference in illusion proneness between groups. This suggests that illusions are not directly related to level of dissociation.
					MGT			

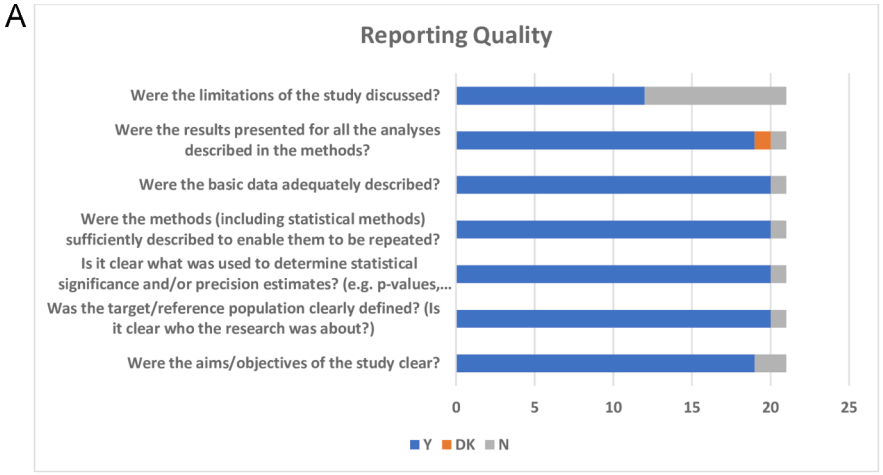
(*continued on next page*)

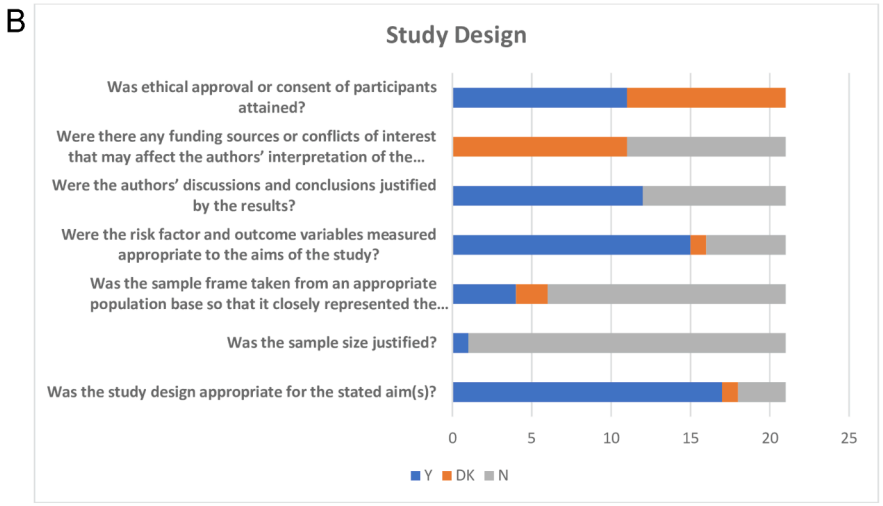
Table 1 (*continued*)

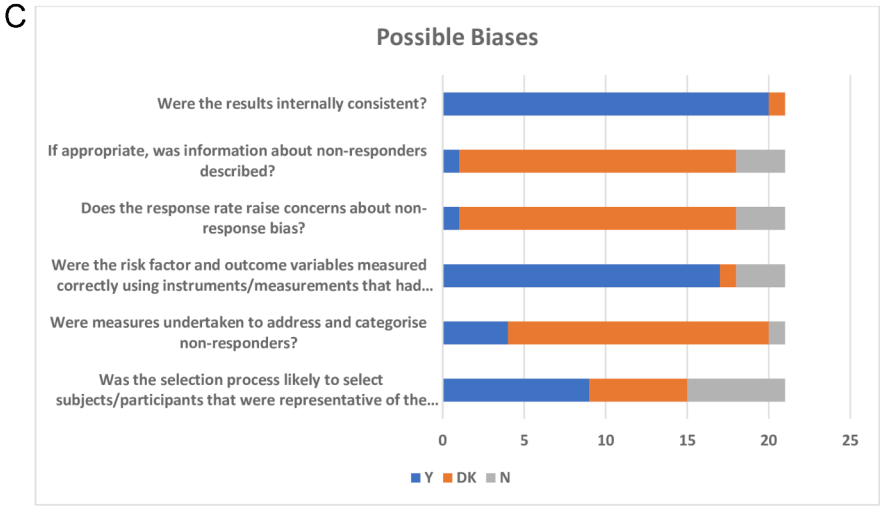
Study	Sample size	Mean Age Years (SD)	Gender M:F	Type	Paradigm	Aim	Outcome	Key findings
Demartini et al. (2020)	Anorexia nervosa (n = 14) Healthy controls (n = 14)	28.3 (10.7) 31.7 (9.8)	0:14 3:11	Clinical group		To assess strange face illusions in relation to dissociative symptoms in anorexia nervosa.	A Short variation of the CADSS SFQ Ad –hoc questionnaire assessing anomalous sensation. SCID-5 used to assess a healthy state. Eating Disorders Inventory-2	A higher number of illusions and dissociative symptoms in anorexia nervosa patients compared to controls. Illusions were correlated with body dissatisfaction.
Pick et al. (2020)	Functional neurological disorder (n = 19) Healthy controls (n = 20)	44 (20) 27(9.8)	4:15 4:16	Dissociation induction	MGT	The impact of dissociation on interoceptive processing in individuals with functional neurological disorder.	Traumatic Experiences Check list. Multidimensional Assessment of Interoceptive Awareness. Patient Health Questionnaire. Extended Patient Health Questionnaire −15. General Anxiety Disorder-7 CADSS Positive and Negative Affect Schedule Interoception task (Heartbeat Tracking Task)	Functional neurological disorder patients had elevated state dissociation compared to controls both before and after MGT. Interoceptive accuracy was negatively affected in functional neurological disorder patients group post MGT compared to control. This suggests that individuals with functional neurological disorder experienced greater susceptibility to dissociation leading to metacognitive deficits and impaired interoceptive accuracy compared to controls.
Caputo (2021)	Non-clinical participants (N = 12)	21.3 (1.7)	3:9	Validity	MGT	Split mirror gazing increases dissociative states and illusions of self-identity compared to single mirror gazing.	9 item ad hoc questionnaire (containing 4 items from CADSS, 4 items from SFQ and 1 new item)	All participants perceived illusions. Illusions of new faces were higher in split mirror gazing compared to single, whereas feature deformation and illusions of body detachment were not.
Derome et al. (2022)	Non-clinical participants (N = 216)	Child (n = 68) 10.7 (1.5) Adolescent (n = 86) 16.5 (1.5) Adult (n = 62) 24.6 (2.2)	34:34 33:53 28:34	Prodromal	MGT	To examine the influence of schizotypal personality traits on proneness to experiencing strange face illusions, from a developmental perspective, from childhood to adulthood.	SPQ SPQ-C (child version)	The developmental trajectory of schizotypy dimensions and proneness to strange faces peaked during adolescence. Both positive and disorganised dimensions contribute to the proneness to strange faces. Probability of seeing strange faces was higher in adulthood, compared to childhood, whereas the reverse was true of feature distortions.

Note: Exp = Experimental; MGT = Mirror Gazing Task; IGDT – Inter-personal Gazing Dyad Task.

achieving 80 % "yes" responses indicated high quality, 60–80 % indicated moderate quality, and < 60 % indicated low quality. Thus, 3/21 (14.28 %) studies were rated as high quality, 9/21 (42.86 %) moderate quality and 9/21 (42.86 %) as low quality. Whilst the items relating specifically to reporting quality scored quite highly, the detail relating to study design and possible biases are lower and more variable (see Fig. 3).







(caption on next page)

Fig 3. Results from the AXIS quality assessment of the strange face illusion literature. AXIS Items are grouped together according to items relating to A) reporting quality, B) study design and C) possible biases. Each bar reflects the number of studies that provided details for that item. Studies consistently scored well on clarity of research aims, description of methodology and presentation of results. Specific areas of concern are justification for sample size (1/20), representative sampling (3/20), non-responders (3/20), non-response bias (1/20). Almost half (9/20) provided a declaration relating to conflicts of interest, the other 11 studies did not provide any information – of those 9, no conflicts of interest were declared. More importantly perhaps, study limitations were not discussed in 9/20 studies. A major concern, however, relates to the discussion and conclusion, where almost half of the studies (9/20) contained discussion and conclusions that were rated as not being justified by the results.

3.2. Prevalence of illusions

Several studies have reported that all participants experienced face-related illusions (Caputo, 2010a, 2011, 2013, 2016, 2021; Caputo et al., 2014); however, others suggest that up to one-quarter fail to experience any face-related illusions (though they may report changes in light, colour, or contrast). Brewin and Mersaditabari (2013) found that a loss of identity was reported by about half of their participants. As feature distortions in the MGT are not typically associated with a loss of self-recognition, this suggests that only 50 % of individuals experienced illusions of new "strange faces". Nevertheless, we note that rates of reporting are potentially confounded with other variables, which might include, for example, whether studies have measured lux value at the face, which paradigm used (MGT or IGDT) has been employed and so on. Hence, we examine the absolute and relative impact of such moderator variables on the reported rates of strange faces in studies.

Only three studies grouped participants into individuals who do and do not experience new strange faces (Fonseca-Pedrero et al., 2015; Derome et al., 2018, 2022); though Derome et al. (2018) assess a sub-sample of Fonseca-Pedrero et al. (2015). Derome and colleagues (2018) report that 33.3 % (n = 25) perceived only deformations of their own face, whereas 30.6 % (n = 23) saw another facial identity and 9.3 % (n = 7) had a non-human vision. Fonseca-Pedrero and colleagues (2015) reported 38 % saw a strange face (i.e., other facial identity or non-human vision) and 50 % saw only feature distortions. In terms of those who saw neither strange faces nor feature distortions, Derome et al and Fonseca-Pedrero et al reported 26.6 % and 18.2 % respectively.

Fifteen of the 21 studies (involving 17 data sets, n = 819) provided prevalence data. Table 2 outlines the data classified into the two broad categories: feature distortions of the face being observed and the appearance of new strange faces. We note that three studies (Caputo, 2015, 2017, 2019) did not present overall rates and so, we derived estimates from a single item on the Strange Face Questionnaire - using the SFQ "yes" answers to item 5. "Did you see the face of a stranger or unknown person?" Similarly, for feature distortions, we used data derived from SFQ item 1. "Did you see that some facial traits were deformed?" for Caputo 2015, 2017. The pooled prevalence rate across all 17 data sets (see Fig. 4) was 0.58 (95 %CI 0.48 to 0.68). Analysis of the funnel plot (see Fig. 5) showed asymmetry, and so, evidence of possible small sample bias (where smaller samples produce much larger effect sizes). Trim and fill analysis identified four potentially missing studies and adjusted the effect size to 0.52 (95 %CI 0.42 to 0.63).

Heterogeneity was assessed using the I^2 statistic, and for interpretation we followed Cochrane guidance (Higgins et al., 2019), where I^2 values of 0 %-40 % identified as might not be important; 30–60 % as may represent moderate heterogeneity; 50–90 % may represent substantial heterogeneity; 75 %-100 % representing considerable heterogeneity. Heterogeneity on prevalence rates across studies was considerable ($I^2 = 83.22$, df = 16, $p < .001$).

An exploratory subgroup analysis revealed that strange face illusions were more commonly reported in the IGDT 76 % (95 %CI 68–82; k = 4) than the MGT paradigm 50 % (95 %CI 40–59; k = 13)**:** Q = 16.78, df = 1, $p < .001$. We also found that the illusion was more common in those studies that recorded the lux-value at the face (74 % [95 %CI 62 to 83]; k = 10) compared with those that did not (41 % [95 %CI 34 to 49]; k = 7): Q = 19.23, df = 1, $p < .001$).

Univariate *meta*-regression analyses, using the Method of Moments approach, showed that study quality was inversely related to prevalence, with lower quality studies producing higher prevalence rates (Z = -6.43, $p < .00001$). The R^2 analogue value was 0.87, suggesting that 87 % of the variance in prevalence scores is attributable to study quality. Reported rates of SFIs was also significantly and positively related to age (Z = 2.40, $p = .016$; R^2 analog = 0.19) and to the proportion of female participants per study (Z = 2.90, $p = .004$; R^2 analog = 0.48). Feature distortions also significantly predicted strange face illusion rates (Z = 3.44, $p = .0006$; R^2 analog = 0.68), suggesting an extremely strong relationship between experiencing feature distortions and face illusions. We could not analyse the relationship of face illusions with dissociation scores (as too few studies provided relevant data).

Since the event rate for face illusions was significantly predicted by variables relating to the method (IGDT vs MGT; measuring lux at the face; study quality), the experience of feature distortions and participant-related factors (mean age, proportion of females), we conducted a multiple *meta*-regression analysis. When all variables were entered, multicollinearity emerged with lux recording displaying a high VIF (15 +) and so, was excluded. All other VIFs were acceptable (the largest being for feature distortions at 5.72) and the overall model was highly significant (Q = 59.56, df = 5, $p < .00001$) and produced an R^2 analog = 0.99. The analysis revealed that face illusions were significantly predicted by study quality (Z = -2.49, $p = .01$), while participant age (Z = 0.67, $p = .50$), proportion of female participants (Z = 0.80, $p = .42$), paradigm (Z = -1.77, $p = .08$) and feature distortions (Z = -0.20, $p = .84$) were all nonsignificant. The variability in reported strange face illusion rates appears to strongly reflect the study quality; with higher prevalence being reported in lower quality studies.

3.3. Factors influencing strange face illusion induction.

The combination of three specific experimental manipulations appears to be necessary to induce strange face illusions: a) low light levels, b) an instruction to fixate one's eyes (i.e., gaze into the eyes) for a prolonged period, and c) the presence of a face stimuli (i.e.,

Table 2
Rate of reporting for illusions (from free text written/verbal description or structured interview/questionnaire).

Study	n	Mean Age Years (SD)	Method	Measured lux at face	Sample	Overall face-related Illusions (%)	FD (%)	SF (%)
Caputo (2010a)	50	23 (2.1)	MGT	Y	Non-clinical	100	66	100
Caputo (2010b)	42	23 (2.2)	MGT	Y	Non-clinical	100	67	69
Caputo (2011)	7	44 – 49 range	MGT vs mask on a stand	Y	Non-clinical (worn)	100	71	100
					(non-worn)	57	0	57
Caputo et al. (2012)	21	38.1 (11.8)	MGT	Y	Non-clinical	71	71	48
	16	44.3 (13.4)			schizophrenia patients	100	100	13
Brewin & Mersaditabari (2013)	60	25.4 (2.0)	MGT	N	Non-clinical	50	.	50
Brewin et al. (2013)	60	20.1 (1.6)	MGT	N	Non-clinical	62	.	62
Caputo (2013)	10	27.3 (8.6)	IGDT	Y	Non-clinical	100	.	100
Caputo et al. (2014)	13	40.2 (13)	MGT	Y	Non-clinical	100	.	.
	13	50.0 (14.2)			depression patients	38	.	.
Caputo (2015)	20	21.9 (1.3)	IGDT	Y	Non-clinical	90	90	75
Fonseca-Pedrero et al. (2015)	110	16.3 (1.8)	MGT	N	Non-clinical	81.8	45.5	34.6
Caputo (2016)	15	23.7 (5.4)	MGT	Y	Non-clinical	100	100	53.3
Caputo (2017)	30	21.7 (1.2)	IGDT	Y	Non-clinical	87	87	70
Derome et al. (2018)*	75	16.9 (2.5)	MGT	N	Non-clinical	73.4	33.3	39.9
Caputo (2019)	90	22.0 (2.3)	IGDT	Y	Non-clinical	92	77.8	76.7
Caputo (2021)	12	21.3 (1.7)	MGT	Y	Non-clinical	100	.	.
Derome et al. (2022)	216		MGT	N	Non-clinical	.	47.2	35.6
	68	10.7 (1.5)			(children)	.	38.2	32.4
	86	16.5 (1.5)			(adolescents)	.	52.3	38.4
	62	24.6 (2.2)			(adults)	.	50	35.5

Note: FD – feature distortions of the actual face; SF – new strange faces. Where data regarding feature distortions and new strange faces were not explicitly calculated provided in the paper (e.g., Caputo, 2015, 2017, 2019), it was calculated using the SFQ "yes" answers - for feature distortions we use the data provided for SFQ item 1. "Did you see that some facial traits were deformed?" and new strange faces we use the data from item 5. "Did you see the face of a stranger or unknown person?". As the data provided in the literature are not provided in mutually exclusive groups the columns will not total to 100%. * Derome et al. (2018) is a subsample of participants from Fonseca-Pedrero et al. (2015).

faces or face masks).

3.3.1. Low light levels.

Typically, the light levels measured at the face are reported to range from 0.6 to 1 lx (Caputo et al., 2020). This suggests that illusions are not overly sensitive to a specific value of luminance and have been shown to be robust across a range of low light levels. Some researchers suggest that 0.8 lx is an optimal level for maximum illusion induction, however this has not been empirically established. Only one study (Caputo, 2010b, Experiment 3) directly manipulated light-levels in the MGT paradigm. In a small sample (n = 8), this study reported more frequent reports of illusions (12.5 vs 7.13) in lower-light levels (lower vs higher: 0.8 lx vs 5 lx) as well

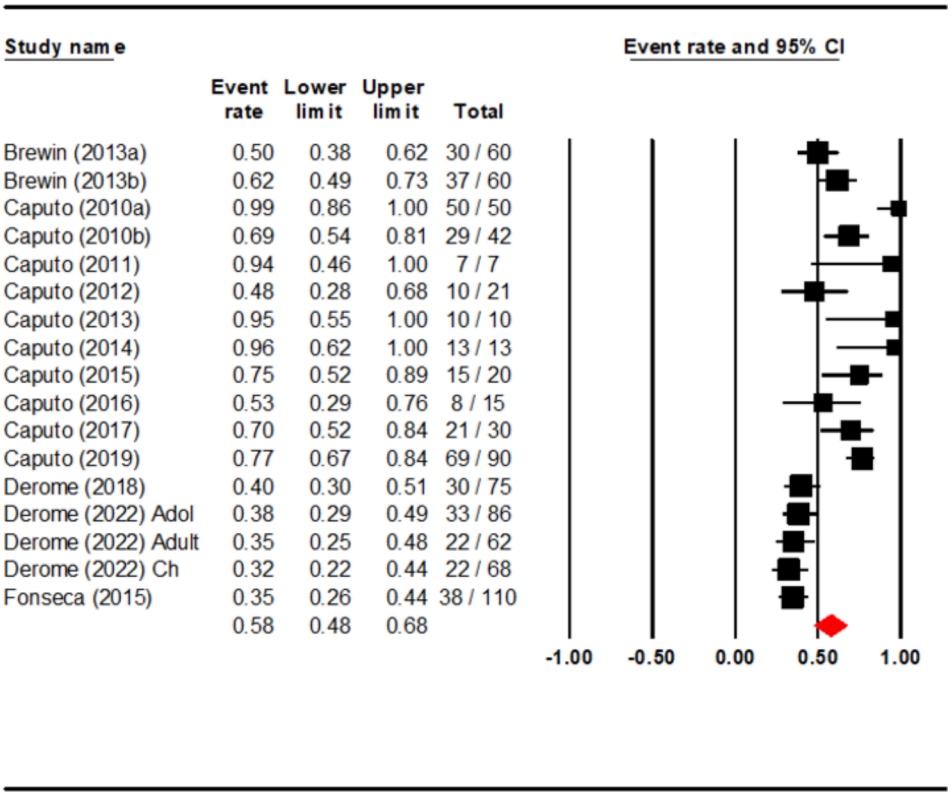


Fig 4. Prevalence of new strange face illusions in non-clinical samples.

as a significantly quicker time-to-onset of illusions (lower vs higher: 0.8 lx vs 5 lx, light levels: 34.75 s vs 62.57); however, duration of illusions did not differ significantly across lighting conditions.

3.3.2. Prolonged gaze fixation

The instruction for participants to 'stare into the eyes' encourages participants to fixate for longer periods than they would normally. Only one study to-date has directly compared eye-gazing to a free-gaze control. In a sample of 40 individuals, Caputo (2015) found that while 75 % of an experimental dyad group experienced SFIs when sat opposite each other, a free-gaze control group sat

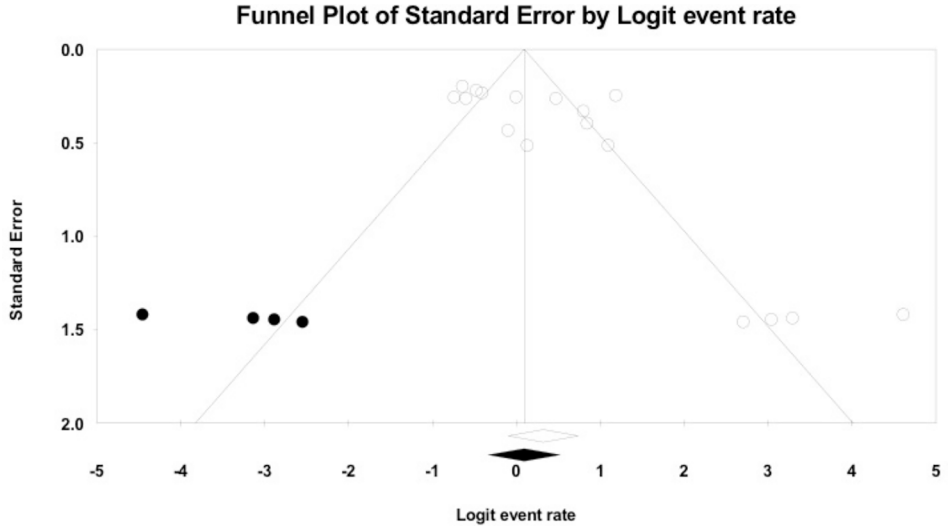


Fig 5. Funnel plot showing possible small sample bias. Note. Open circles represent logit event rates found for studies and filled dark circles represent potentially missing event rates.

adjacent to each other (looking at a wall), without a specific instruction to gaze at anything (i.e., fixate) did not experience any illusions. This suggests that prolonged gaze fixation is a necessary factor in generating SFIs.

3.3.3. Face stimuli

Viewing stimuli with a face configuration also seems to be a necessary condition to induce SFIs. SFIs have been reported in studies using stimuli that include self-face reflections in mirrors (Brewin et al., 2013; Brewin & Mersaditabari, 2013; Caputo, 2010a, b, 2016, 2021; Caputo et al., 2012, 2014; Demartini et al., 2020; Derome et al., 2018, 2022; Fonseca-Pedrero et al., 2015; Nisticò et al., 2020), the faces of others in inter-personal gazing dyads (Caputo, 2013, 2015, 2017, 2019), and facial masks (Caputo, 2011).

One study (Caputo, 2011) has examined whether a 'real' face was necessary by requiring participants to wear a mask during gazing. In a small sample of 7 participants (only 2 of whom were naïve to the paradigm and may therefore have been primed to see illusions), the MGT was conducted whilst wearing a Japanese theatrical mask compared with a non-worn condition in which the mask was positioned on a stand in front of the participant. SFIs occurred in both worn and non-worn conditions, consistent with the notion that stimuli with a face configuration, rather than an actual face, is necessary for SFI induction. Interestingly, wearing the mask increased the illusory effect on various metrics (i.e., worn vs non-worn mask conditions: mean frequency 1.8 vs 0.4 illusions per minute; mean duration 7.9 vs 2.8 secs; and time-to-onset 54 vs 125 secs).

By contrast, mirror gazing at non-face stimuli does not result in illusions. Caputo (2013) conducted a control condition that involved a fixation dot on the chest, with no illusory changes perceived in the body surrounding the dot. Jenkinson & Preston (2017) also failed to induce illusions using whole-body stimuli (although light levels involved a 40 W bulb rather than the recommended 20 W). Caputo et al. (2012) also report a preliminary experiment, in which three patients with schizophrenia undertook a dot-gazing session under low light levels, with no apparitions reported.

3.4. Illusion measurement

Several studies have directly captured the frequency and duration of SFIs (Caputo, 2010b, 2011, 2013; Caputo et al., 2012, 2014; Derome et al, 2018) with participants instructed to depress a button in response to the onset of any unusual experience and release the button when the experience subsides. Others have required participants to complete the self-report 'Strange Face Questionnaire' post-testing (Caputo, 2015, 2017, 2019; Demartini et al., 2020; Nisticò et al., 2020). Finally, some have obtained qualitative data of strange face illusions using free-text descriptions (Caputo, 2010a, b, 2011, 2016), short interviews with participants (Caputo, 2013; Caputo et al., 2012, 2014) or ad hoc questionnaires (Caputo, 2021; Derome et al., 2018, 2022; Fonseca-Pedrero et al., 2015).

Table 3
Response-button data (means and standard errors) for illusion frequency, duration, and time-to-onset in non-clinical samples.

Study	Paradigm	Type of illusion	Frequency (min^{-1})	Duration (s)	TTO (s)	Instruction for Response Button
Caputo (2010b)	MGT	SF & FDs	1.96	6.9	50.4	Exp 1 – "If you see perceptual changes on your face"
	MGT	SF only	1.65	7.3	48.6	Exp 2 – "If you perceive a new face"
Caputo (2011)	MGT & Mask (worn)	SF & FDs	1.8 (0.3)	7.9 (0.5)	54 (19)	"Once you perceive the mask as alive…."
	Low light & Mask (non-worn)	SF & FDs	0.4 (0.2)	2.8 (0.6)	125 (10)	
Caputo et al. (2012)	MGT	SF & FDs	0.8 (0.2)	4.44 (0.9)	145 (35)	"You may or may not notice changes in your face…"
Caputo (2013)	IGDT	SF & FDs	2.4 (0.4)	4.65 (0.6)	30.7 (7.9)	"You may or may not perceive changes in the face of the other participant…."
Caputo et al. (2014)	MGT	SF & FDs	0.8 (0.2)	6.1 (1)	175 (38)	"You may or may not notice changes in your face…"
Fonseca-Pedrero et al. (2015) *	MGT	SF & FDs	1.64 (0.15)	3.80 (0.5)	51.24 (7.0)	"You may or may not notice changes in your face…"
Derome et al. (2018) *	MGT	SF & FDs	1.67 (0.18)	6.01 (1.8)	53.70 (9.5)	"You may or may not notice changes in your face…"
		FDs only	0.03 (0.003)	4.63 (1.0)	43.05 (7.2)	
		SF only	0.03 (0.002)	8.65 (2.63)	71.8 (12.4)	

Note: Frequency & duration data were captured by response button. Derome et al. (2015) data refers to their cross-sectional analysis data as this is based on a larger sample size. Reported values for frequency in Fonseca-Pedrero et al. (2015) and Derome et al. (2018) referred to total frequency across 10 min (personal communications), above we report actual values reported/10. * Reported SDs were converted to SEMs for consistency, where SEM = SD/$\sqrt{}$(N).

3.4.1. Response button data for frequency, duration & time-to-onset of illusions

Table 3 summarises data relating to the frequency, duration, and Time-To-Onset (TTO) of illusions. Notably, all measures display substantial variability across studies and method of induction (though only one IGDT study has assessed button press). Frequency varies from 0.4 illusions/min in the MGT (Caputo, 2011) to 2.4 illusions/min in the IGDT (Caputo, 2013); duration from 2.8 s using non-worn masks (Caputo, 2011) to 8.65 s in the MGT (Derome et al., 2018); and TTO from 30.7 s in the IGDT (Caputo, 2013) to 175 s in the MGT (Caputo et al., 2012). Drawing definitive conclusions concerning what the response button data indicate is problematic given the variability in specificity of the instructions across studies, and that this measure conflates feature distortions with the emergence of new strange faces, thus confounding the possibility of distinguishing between these illusions.

3.5. Strange face illusion phenomenology

A wide range of illusions are commonly reported. The illusory phenomena stem from simpler, non-face related illusions (i.e., changes in light and colour contrast) through to more complex, face-related illusions which include feature distortions on the actual face (i.e., distorted/disappearing features) and new strange faces (i.e., familiar faces, relatives, archetypal faces - old sage, witch, ancestor, animal, or monstrous faces).

3.5.1. The strange face questionnaire (SFQ)

The SFQ is a structured questionnaire that captures descriptive and frequency information. The questionnaire items draw largely upon Carl Jung's concept of archetypes derived from his work on Self, Shadow, and Identification (Jung, 1991). The SFQ encourages participants to select a narrative/description that relates most closely to their experiences, but within various archetype descriptions (e.g., Did you see the face of a monster; an androgyne; an old person; a hero or heroine; a spiritual person; a domestic or savage animal?). The SFQ also contains a single item relating to feature distortions, i.e., Did you see that some facial traits were deformed? The original SFQ (Caputo, 2015) consisted of a 15-item questionnaire that increased to 19 items (Caputo, 2017; 2019) and later 28 items (Demartini et al., 2020; Nisticò et al., 2020). The response to each item is "no" or "yes"; if a "yes" response is given then it is rated on a 4-point scale (Caputo, 2015, 2017) with increments relating to "rarely" (1) to "extremely" (4), or a 5-point Likert scale (Demartini et al., 2020; Nisticò et al., 2020) with increments progressing from never (0) to always (4).

3.6. Psychological associations with illusions

3.6.1. Dissociation

In addition to inducing visual illusions, both the MGT and the IGDT are associated with an increase in dissociative states. Indeed, several studies have employed the MGT paradigm to induce dissociation and examine its negative impact on various cognitive domains, including attention and memory (Brewin & Mersaditabari, 2013; Brewin et al., 2013), emotional numbing (Shin et al., 2019), interoception (Pick et al., 2020) and guilt (Rugens & Terhune, 2013).

Five studies included measures both for illusions and for dissociation (Caputo, 2015, 2019, 2021; Demartini et al., 2020; Nistico et al., 2020), although only two have examined non-clinical, healthy participants. Using the IGDT, Caputo (2019) found that SFQ total scores and CADSS total scores correlated significantly ($r = 0.56$, $p < 0.001$) in a sample of 90 participants; however, in another study of 20 dyads, Caputo (2015) found that the correlation between dissociation and illusions was weaker and failed to reach significance ($r = 0.33$; $p = 0.15$). Taken together these findings suggest that the emerging relationship between illusions and dissociation has yet to be robustly established in this paradigm and the latter IGDT study may have been underpowered.

Recent studies (Caputo, 2019, 2021; Caputo et al., 2020; Demartini et al., 2020; Nisticò et al., 2020) suggest that different types of illusory faces emerge in relation to different dissociation subtypes. Given the proposed importance of dissociation in the generation of new strange faces, we might ask to what extent do the levels of this dissociation emerge in other related contexts? Typical baseline CADSS scores in healthy participants fall between 1.55 and 6.27 (Brewin et al., 2013). Lowering light levels alone appears to increase dissociation as demonstrated by Caputo's (2015) control group who stared at a wall under low light levels and reported CADSS scores of 7.25. By contrast, gazing at static photos of faces in normal light levels results in state dissociation of 7.94 (Möllmann et al., 2020); mirror gazing under normal light levels produces a mean CADSS score between 2.7 (Brewin & Mersaditabari, 2013) and 9.86 (Jenkinson & Preston, 2017). The CADSS scores associated with the MGT include scores ranging from 7.8 (Nistico et al., 2020) to 18.72 (Brewin et al., 2013). By contrast, interpersonal gazing dyads under low light levels, appear to induce a far greater state of dissociation with CADSS scores of around 27 (Caputo, 2015, 2019). However, the absolute level of CADSS scores alone cannot account for the emergence of new strange faces. For example, PTSD following exposure to traumatic memories is associated with higher CADSS scores in the region of 35 (Bremner et al., 1998) and do not report strange faces illusions.

3.6.2. Prodromal studies: Strange face illusions as artificially induced anomalous subjective experiences.

Three studies (Derome et al., 2018, 2022; Fonseca-Pedrero et al., 2015) employed a clinical approach, whereby the MGT paradigm was used to experimentally induce SFIs, on the theoretical basis that these illusions appear to be superficially similar to some Anomalous Subjective Experiences (ASEs) that are associated with various forms of psychopathology. ASEs refer to various psychic phenomena that include: the sense that you are not 'real' (distortions in experience of self and being) and anomalous perceptual experiences (distortions of sensory events) (see Wright et al., 2018). The combination of visual illusions and increased dissociative state induced by the SFI paradigm is considered experientially akin to some types of ASE associated with psychosis or schizophrenia. Since early detection of such disorders may be achieved by investigating naturally occurring prodromal experiential anomalies (i.e.,

ASEs), some researchers have investigated SFIs in adolescents to assess if proneness to new strange faces could serve as an artificially induced prodromal expression of schizotypy. Fonseca-Pedrero and colleagues (2015) found that 34.6 % of 110 non-clinical adolescents reported new strange faces and had higher scores on the cognitive-perceptual and disorganization domains of the Schizotypal Personality Questionnaire (SPQ) (Raine, 1991).

Employing functional Magnetic Resonance Imaging, Derome and colleagues (2018) conducted a resting state network analysis of 75 adolescents, to examine if functional connectivity varied between individuals who saw new strange faces (i.e., ASE) compared to those who did not (no-ASE), in addition to an assessment of schizotypal personality traits. Compared to the no-ASE (i.e., feature distortions & no illusions) group the ASE (i.e., new strange faces) group showed significantly decreased within-network connectivity in some subclusters within the Primary Visual Network (PVN: right fusiform gyrus and superior parietal lobule) and greater co-activation of some sub-clusters within the dorsal Default Mode Network (DMN) in the left middle occipital gyrus. However, the between network analysis was non-significant. For the strange face group, the atypical connectivity of the visual area within the DMN was associated with higher scores on the disorganised dimension of schizotypy at both the first and second time points (1 year later), thereby supporting the view of a subtle difference in connectivity in the resting state networks of those who experience new strange faces. However, as the fMRI was not conducted during the MGT the functional connectivity patterns do not relate directly to neural activity associated with illusions.

The relationship between strange faces (i.e., ASEs) and schizotypy was further investigated by Derome and colleagues (2022). This developmental study examined strange face illusions in children (n = 68), adolescents (n = 86) and adults (n = 62). Adolescents were identified as being the most prone to strange faces, compared to both children and adults and the developmental trajectory of illusions was found to be very similar to that of the dimensions of schizotypy. Interestingly their developmental model indicated that the positive and disorganised dimensions of schizotypy predict strange faces. Thereby supporting the notion that schizotypy might confer a perceptual bias during adolescence.

3.6.3. Empathy, facial mimicry, and contagion

Two studies have investigated the relationship between illusions and empathy in both the IGDT and the MGT paradigms. The degree of illusion synchronicity between individuals during the IGDT has been identified as an indicator of empathy. Caputo (2013) reported that synchronous illusions (defined as any degree of overlap) were reported by 50 % of participants in 10 dyad pairs. Empathy was proposed to be a key mechanism leading to increased dissociation and illusion formation in interpersonal gazing dyads. In a later study using the MGT in a small sample (n = 15), Caputo (2016) reported that illusions correlated significantly with empathetic personality traits (as measured by the Interpersonal Reactivity Index, IRI) (Davis, 1983), at least on the IRI subscales: fantasy (r = 0.66) and empathetic concern (r = 0.66). Caputo (2016) proposes that the latter correlation reflects individual differences in vulnerability to contagion and mimicry, while the correlation with the fantasy subscale reflects individual differences in cognitive empathy.

3.7. Strange face illusions in clinical populations

Four studies have investigated strange face illusions in clinical groups, all employing the MGT paradigm (Caputo et al., 2012, 2014; Demartini et al., 2020; Nisticò et al., 2020). Caputo and colleagues (2012) found a significantly higher frequency and longer duration of illusions in patients with schizophrenia (n = 16) compared to non-clinical controls (n = 21). In terms of illusion content, however, more patients experienced feature distortions than controls (100 % patients vs 71 % controls), but a higher percentage of controls perceived new strange faces in the mirror than patients (controls 48 % vs patients 13 %). Demartini and colleagues (2020) found that compared to non-clinical controls (n = 14), individuals with anorexia nervosa (n = 14) had SFQ total scores indicating that they experienced significantly more new strange faces than healthy controls, although the two groups experienced comparable numbers of feature distortions. Finally, Caputo and colleagues (2014) reported that 13 hospitalised depressed patients tended only to perceive mild feature distortions (i.e., very faint changes), with 62 % of depressed patients not seeing any illusions at all.

Some clinical groups have shown levels of illusions that are comparable to non-clinical controls. Employing the MGT, Nisticò and colleagues (2020) found that patients with psychogenic non-epileptic seizures (n = 11) and functional movement disorder (n = 17) did not differ in total illusions when compared to healthy controls (n = 18). Nonetheless, psychogenic non-epileptic seizures patients scored significantly higher on the CADSS (i.e., demonstrating increased state dissociation) than healthy controls, but no significant between groups difference emerged in the either the SFQ total score or frequency of illusions.

3.8. Interpretation of illusions

Feature distortions are suggested to be mechanistically distinct from new strange faces. For instance, Caputo (2014) describes feature distortions as "*perceptual and involve the Troxler effect. This effect can explain the merging of facial features into a uniform silhouette of the facial contour; however, perception of entirely new faces remains unexplained*" (p5). Given that a perceptual account of new strange faces was lacking, key researchers concluded that the complexity, diversity and specificity of strange face illusions "suggest mechanisms beyond perceptual distortions or illusions" (Caputo et al, 2020, p1). Hence illusory new faces were conceptualised as a psychological, not perceptual, phenomenon.

Initially, a psychodynamic explanation was advanced, in which it is argued that different types of strange faces represent different aspects of the self (Caputo et al., 2014). For example, Caputo (2010b) asserts that "*apparitions of another person in the mirror (*e.g.*, parents with deformed traits), and of strange beings (*e.g.*, witch, ghost, skeleton) could be manifestations of an individual's Shadow*", whereas "*apparitions in a mirror of archetypal people (*e.g.*, old woman, child) of ancestors and of animal faces (*e.g.*, cat, pig, lion) could be*

manifestations of an individual's Self' (Caputo 2010b, p. 1136–1137). Thus, strange faces were suggested to represent unconscious 'narrative identities' that involve "projections of the subject's unconscious" (Caputo, 2017, p379). This account posits that strange faces are more than a visual illusion, representing personalities and not only faces.

Taking a more clinical approach, strange faces have also been conceptualised as anomalous subjective experiences akin to the depersonalisation-like experiences in schizophrenia (Caputo et al., 2020; Derome et al., 2018, 2022; Fonseca-Pedrero et al., 2015). Derome et al., (2018) proposed a 'Self-Referential Processing (SRP) Network Hypothesis', based on fMRI findings from a resting state analysis, indicating atypical functional connectivity within some sub-clusters of the primary visual network and default mode network in participants who report strange faces. This model proposes a potential disconnection between these cortical areas associated with different levels of self-referential processing (as described by Northoff et al., 2006). More specifically, a disconnection between the bodily-self as associated with sensory processing (i.e., primary visual network), and the cortical areas associated with minimal psychological self (i.e., default mode network). Derome et al., (2018) hypothesize that this disconnection in bottom-up regulation could interrupt self-face recognition and, in a similar manner to other visual illusions, over-weight top-down modulation leading to the generation of illusions.

A more recent conceptualisation marries aspects of Derome et al's (2018) self-referential processing account with Caputo's (2019, 2021; Caputo et al., 2020) dissociative psychodynamic account of SFIs. Illusions are classified into three prototypes derived from a Principal Component Analysis using items from the CADSS and SFQ; with different illusions being correlated with different dissociative sub-types (Caputo 2019). Following Derome et al. (2018), Caputo (2019) proposes that each prototype relates to different levels of self-referential processing. Face deformations and many types of strange faces are considered to be self-body illusions that are associated with *derealisation*; body detachment illusions, (i.e., sensed presences and immobile faces) are proposed to be minimal-self illusions associated with *depersonalisation*; the remaining types of strange faces were independent of dissociation. Notably the CADSS does not contain any items that relate to fragmentation of the sense of the self (Bremner et al., 1998); however, the remaining strange faces are reported to relate to "dissociative identity", which are proposed to be identity illusions where "the subjects face is projected into the others face" (Caputo, 2019, p17).

Finally, we note that Caputo et al. (2020) proposes different mechanisms induce dissociation in the mirror-gazing and the eye-to-eye gazing paradigms. Caputo (2013) suggested that illusions in inter-personal dyads are a form of Jungian synchronicity between the somatic, emotional, and psychic domains of the two individuals in the dyad. For mirror-based illusions, Caputo et al. (2014) identifies empathy, somatic/motor mimicry and contagion as the key psychological mechanisms leading to an increase in state dissociation; and that a 'rebound to reality' due to sensory deprivation results in psychodynamic projection of unconscious mental contents onto the mirror in the form of illusions. In contrast, the most recent explanatory account, as described by Caputo (2019), states that illusions can be produced by momentary discontinuities in integration of representations at 3 levels of self-referential processing, thus causing different states of consciousness: derealisation, depersonalisation, and dissociative identity. Taken together, this complex psychodynamic interpretation of illusions positions multiple psychological processes as causal mechanisms underpinning new strange faces (see Caputo, 2017, 2019; Caputo et al., 2014, 2020).

4. Discussion

The present systematic review and *meta*-analysis provides a comprehensive synthesis and evaluation of the strange face illusion literature, the methodological quality of studies, and existing interpretations of strange face illusions. Our searches identified 21 studies (N = 1,132) involving non-clinical and clinical samples conducted over the past 12 years. Based on 17 datasets derived from non-clinical participants, we estimate the prevalence of illusions of new strange faces to be reported by almost 60 % of individuals.

Assessment of study quality using the AXIS revealed that overall quality for most studies (85 %) was in the low-to-moderate range. At a more specific level, while AXIS items relating to reporting quality were good, issues arose concerning study design and possible biases. Key areas of methodological concern are the often-small sample sizes, the lack of *a priori* power analysis, providing conclusions and interpretations that are not justified by the results, and a lack of discussion of limitations. Discussion of limitations is a key part of both scientific discourse and scientific progress, allowing readers to assess the validity of scientific work and to contextualise research findings (see Ioannidis, 2007), and has been viewed by some as partly a failure of the peer review process (Horton, 2002). Although not part of the AXIS, we also note that to-date, no published studies have been preregistered.

Meta-regression analyses identified two participant-based variables with higher rates of strange face reporting in samples that are older and with a higher proportion of female participants. Whilst exploratory, these findings are intriguing and not previously documented. The finding that strange face illusion reports were higher in samples with more female participants requires further investigation. The finding on age contrasts with work showing that both auditory and visual hallucinatory-type experiences in the general population tend to be more common in younger rather than older individuals (e.g., Larøi et al., 2019; Maijer et al., 2018). This suggests perhaps that strange face illusions may be different in kind from other hallucinatory-type experiences reported in the general population. Another possibility is that older individuals are more reticent to report spontaneous hallucinatory experiences, but the strange face paradigm provides a less threatening context to explore the emergence of unusual visual experiences. At a pragmatic level, poorer low-light vision in older individuals may also play a role in their higher rates of strange face illusions (see Beck & Harris, 1994). Despite this emphasis on age, most samples assessed within the strange face paradigm have been quite young (overall mean age of 28.3 years). Future research is required samples to determine if the age effect persists across a broader age range. Closer examination of age effects in future studies may also help reveal the mechanisms underlying SFIs, in the same way that studies of age effects in other visual, auditory, and multisensory illusions have provided unique insights into their cause (Billino et al., 2009; Campos et al., 2018; Doherty et al., 2010; Hirst et al., 2019; Mullin et al., 2021). Finally, we note that the recent Rasch analysis of SFQ items by Lange et al. (2022)

did not find any evidence of significant differential item bias relating to either age or sex. This suggests that the moderating impact of both sex and gender reported in our *meta*-analysis are probably not a reflection of SFQ item bias.

To date, studies have rarely systematically assessed how the manipulation of study design features impact the reporting of strange face illusions. Our exploratory *meta*-regression analyses identified the importance of overall study quality (AXIS ratings), while subgroup analyses showed reporting rates are also significantly impacted by the paradigm employed (being greater for IGDT than MGT) and whether lux was measured at the face (greater when lux measured than not). The level of strange face illusions was also highly related to the level of feature distortions reported across studies. Most striking however, was the finding that study quality accounted for 87 % of the variance in prevalence rates, which crucially remained the only significant predictor of SFIs when all variables were entered into a multiple *meta*-regression. With current evidence, it is difficult to completely unpack this finding, as some of the mentioned variables may be confounded or interact e.g., lower quality studies have tended to also examine samples with more women and who are older. So, while demographic variables (age and gender), procedural variables (paradigm type, whether lux is measured at the face) and the levels of reported feature distortions are important to assess, study quality remains the best predictor of strange face illusion prevalence – being higher in studies with lower rated quality.

The influence of the direct environment is a key factor in this paradigm because dimmed light only allows the observer to perceive a vague view of the face. Only one study has examined manipulating light levels (Caputo, 2010b) - using two levels (0.8 vs 5 lx) with a small sample (n = 8) in the MGT. In this counterbalanced within-subject design, all eight participants reported apparitions of a new face in both conditions, but significantly more in the lower light condition. Caputo also reported a significantly quicker time-to-onset of illusions in lower-light levels (34.75 s vs 62.57 s). Generally, researchers have advocated that 0.8 lx measured at the face is the optimal level for illusion induction. In this context, we note that measuring the lux-value at the face has been inconsistent across studies. Our analyses show that reporting of strange faces is more common when lux value is established within the suggested range compared to when lux value is not assessed at all (74 % vs 41 % respectively). However, this finding is limited by the fact that all studies that measuring lux levels at the face were conducted by the same author (G Caputo).

Studies show that different forms of facial configuration can induce strange face illusions, including self-face reflections, the faces of others and even face masks. By contrast, non-face stimuli such as the torso of the body (Jenkinson & Preston, 2017) or a simple dot (Caputo, 2013) fail to elicit illusions. It remains unclear however if it is faces *per se*, stimulus complexity, expertise, or familiarity with the task (i.e., face-gazing) that drives the illusion. Moreover, since masks induce the effect (Caputo, 2011), the face does not need to be human or show mobility – suggesting that a *face-like configuration* is sufficient to induce illusions.

While faces in various formats induce illusions, it is also notable that the reporting of new faces is significantly greater for interpersonal gazing than for mirror gazing (76 % vs 50 %). Although the IGDT and MGT paradigms share common experimental components necessary to induce face-related illusions (i.e., prolonged gaze fixation, low light levels and facial stimuli), the greater prevalence for the IGDT suggests that additional paradigm-specific factors may also be relevant. The IGDT clearly differs in terms of its social context – involving the presence of strangers in a potentially awkward or unusual social situation, where participants are required to stare intently at each other. The IGDT has also been associated with greater levels of dissociation, with CADSS scores of around 27 (Caputo, 2015, 2019) while the MGT has lower CADSS scores, ranging from 7.8 (Nisticò et al., 2020) to 18.72 (Brewin et al., 2013). Whether dissociation is a precursor, a consequence or coincidental with the illusion remains to be established. Nonetheless, links between prolonged fixation and dissociation are well-documented and occurs irrespective of the stimulus type (object, dot, own face in the mirror, photographed face: see Möllmann et al., 2019). Mild dissociation and very mild dysmorphic effects, such as an increase in perceived unattractiveness (Mollman et al., 2019) often co-occur to a minor degree during any mirror-gazing. Prolonged fixation may well underpin the emergence of feature distortions. Indeed, Caputo proposed that the fixation triggered Troxler effect *"can explain the merging of facial features into a uniform silhouette of the facial contour"* (Caputo, 2014, p5). Troxler fading (Troxler, 1804) typically occurs when fixation is maintained on a particular point on an unchanging stimulus, and even after short durations the peripheries (i.e., away from the fixation point) will fade away and disappear. Troxler fading however can only account for the disappearance of features surrounding the point of fixation on the face, which is a commonly reported illusory effect in this paradigm, but not for the merging or blending of features. These illusory effects likely result from other perceptual processes such as, for example, perceptual (textural) filling-in (Komatsu, 2006; Hsieh & Tse, 2009). Such perceptual processes may be employed to deal with a paucity of sensory data arising from the combination of prolonged gaze fixation (i.e., impairing our ability to selectively harvest higher acuity visual information) and low light levels (i.e., impairing one's ability to discriminate fine details of the face, attenuating colour perception etc.).

When appraising the role of prolonged fixation, the evidence assessing SFIs in various clinical groups could prove particularly informative. Whilst increased rates of illusions have been documented in individuals with anorexia nervosa (Demartini et al., 2020), hospitalised, depressed patients tended only to perceive mild feature distortions, with almost two-thirds not seeing any illusions at all (Caputo et al., 2014). Given that prolonged fixation seems crucial to the generation of strange face illusions, some of the variation between clinical groups may derive from differences in ability to maintain fixation and the fact that atypical eye-movement accompanies some disorders. For instance, compared to healthy controls, patients with depressive disorder show significantly abnormal eye-movement indices. For example, patients with depressive disorder exhibit shorter fixation durations (Li et al., 2016) and this may potentially account for their reduced susceptibility to illusions in this paradigm. By contrast, people diagnosed with schizophrenia and non-clinical participants have remarkably similar fixation performance in terms of number and duration of fixations (Kissler & Clementz, 1998; Manor et al., 1999) and so, might be as prone to the illusion as healthy controls. We note however that the findings in clinical groups have yet to be replicated and currently comprise analyses of relatively small samples. Furthermore, it would be crucial to investigate if any links between proneness to strange face illusions and transdiagnostic fixation issues reflect state or trait aspects of such disorders.

The loss of actual face-recognition has frequently been interpreted in this literature as a loss in self-identity (Brewin & Mersaditabari, 2013; Brewin et al., 2013; Caputo, 2010a, b, 2011, 2013, 2015, 2016, 2019, 2021; Caputo et al., 2012, 2014). Although MGT studies might lend themselves towards such an interpretation, a loss of self-identity cannot account for strange face illusions in the IGDT paradigm where self-recognition is not a factor, but where the illusion is more frequently reported. Our finding that illusions are reported by significantly more individuals in the IGDT than MGT paradigm does however accord with Caputo's (2013) speculation that "If empathy is involved, then one should expect a higher frequency of illusions in inter-subjective gazing than in mirror-gazing" (p. 327). Empathy has been seen as central to increased dissociation and illusion formation in both the MGT (Caputo, 2016) and in IGDT (Caputo, 2013) paradigms, although dyad inducement has been linked loosely to Jungian notions of synchronicity. Nonetheless, only four studies to-date have employed the IGDT paradigm (Caputo 2013, 2015, 2017, 2019) and further research is required to address the converging and diverging mechanisms and moderators across the two paradigms.

A key conceptual notion concerns whether SFIs are akin to the depersonalisation-like symptoms of "not recognising oneself in the mirror" (Fonseca-Pedrero et al., 2015; Caputo et al., 2020; Derome et al., 2018, 2022) or even "out of body" experiences (Caputo, 2014). In this context, Caputo's (2019) factor-analysis of Strange Face Questionnaire (SFQ) and Clinically Administered Dissociative States Scale (CADSS) data, from 90 healthy participants who participated in the IGDT, identified three factors. Feature distortions and most types of SFQ responses (8 items) loaded onto a *derealisation* factor (anomalous experiences of external reality, including faces). A further 7 items loaded onto a *dissociative identity* factor (anomalous experiences of identity/self) - although this factor was independent of any sub-type of dissociation as measured by the CADSS). Only four out of 19 items loaded onto the final factor identified as *depersonalisation*. More recently, Lange et al. (2022) re-assessed the same SFQ data from Caputo (2019) using a Rasch approach. Although the sample size (N = 90) is quite small for Rasch analysis (as it is for factor analysis), the authors identified potential problems with almost half of all SFQ items. For the *depersonalisation* factor, three of the four items displayed significant 'extremity' bias (i.e., these items were disproportionately easier to endorse for high than low SFQ scorers) suggesting that the depersonalisation factor is confounded by item difficulty bias. Most importantly, both the exploratory factor structure and the Rasch analysis require replication in a larger sample, with an age range that is broader (mean age = 22; range 19–36) and crucially, as Lange et al. (2022) acknowledge, should be extended to see if a comparable factor structure exists for data derived from the far more frequently examined MGT. This latter point is important given that we have shown that the IGDT paradigm induces a significantly greater prevalence of strange face illusions than the MGT.

Hallucinatory and complex illusory experiences are notoriously hard to introspect, assess and measure (see Rogers et al., 2021). Some issues relating to the assessment of strange face illusions stem from the identifying and capturing the fleeting experiences themselves, but others relate to how the measures used might frame the experience. The Strange Face Questionnaire (SFQ), which provides the main formal assessment of the illusions, is directive insofar as it requires participants to interpret their illusions by choosing pre-selected (often Jungian) narratives that may embellish participant responses e.g. Did you see the face of a hero or heroine? Did you see the face of a spiritual person? Did you see the face of a sexually undefined person or an androgyne? Additionally, the SFQ is administered *after* the experimental task and so participants are reporting on their recollections of their experiences. Given that the MGT has been used to induce dissociation (Brewin & Mersaditabari, 2013; Brewin et al., 2013; Pick et al., 2020; Rugens & Terhune, 2013; Shin et al., 2019) and that dissociation induced by the MGT has been shown to immediately impact memory, including visual memory (Brewin & Mersaditabari, 2013; Brewin et al., 2013) the reliance on memory, coupled with the requirement to choose a descriptive/narrative approximation, is likely to create significant demand characteristics. Nevertheless, making verbal reports 'in-the-moment' may be highly disruptive to both the process and the experience. It is also worth noting that while most studies have recruited participants who are naïve to the tasks (though see Caputo, 2011), priming and expectation effects remain a possible influence. Some evidence suggests that even those who are naïve to sensory-deprivation type paradigms are still able to predict the experience of visual hallucinations in such circumstances (see Jackson Jr & Pollard, 1966). Future studies should therefore examine the possible influence of priming, expectation, and demand characteristics within both the IGDT and the MGT paradigms.

The other commonly used method to assess strange face illusions has been the response-button. Some variability in frequency, duration of illusions and time-to-onset may reflect individual differences in thresholds for decision-making. Equally important is that the single response button is used to subsume a variety of illusory experiences into a single response and so, confounds estimates for feature distortions and new strange faces. In this context, one study (Caputo, 2010b) conducted separate experiments in which two separate participant samples were instructed either in experiment 1 to report "perceptual changes of their own face in the mirror" (p. 1127), (which would include both feature distortions and new strange faces) or in experiment 2 "to respond to new face apparitions" (p. 1130). Caputo reported that frequency, duration, and time of first apparition did not differ across experiment 1 and 2. However, given that we cannot assess the relative proportions of feature distortions to strange faces that were captured by this single phenomenological measure in experiment 1, we cannot eliminate the possibility that the two experiments are comparing two similar sets of face-related illusion experiences. Future studies should aim to potentially characterise feature distortions versus new face illusions using independent response measures.

Turning to limitations of the current systematic review and *meta*-analysis. Our assessment of study quality using the AXIS has certain limitations as far as total summed quality scores should be regarded with some caution as individual items are not weighted (Greenland & Robins, 1994; Jüni et al., 1999; Greenland & O'Rourke, 2001). This means that any two studies with the same total AXIS score, but derived from different items, may not be directly comparable as some items may be assessing more vital aspects of quality than other items. We therefore also examined the relative strengths or weaknesses across studies on domains of quality. Another factor that may have impacted the prevalence rates for strange face illusions reported here is that in three studies (e.g., Caputo, 2015, 2017, 2019), we relied upon estimates derived from a single item on the Strange Face Questionnaire - using the SFQ "yes" answers to item 5 (Did you see the face of a stranger or unknown person?). Similarly, for feature distortions, we used data derived from SFQ item 1 (Did

you see that some facial traits were deformed?). While single items may over-simplify the reported experience, we preferred the use of a single item over multiple items to avoid double counting. For example, a single strange face experience can be registered multiple times on the SFQ (e.g., the illusion was an old person, who looked spiritual, but they had a similar nose to me, and they were of a different ethnicity).

Our review highlights the need to call for external validity given that the reporting rates of new faces (see Fig. 4.) show considerable variability across studies, with a downward trend over time from 100 % (Caputo, 2010a) to 32 % (Derome et al., 2022). Overall, one author (Caputo, who originated the illusion) is an author in almost three-quarters (15 /21) of the studies reported here. Caputo is, to date, the only author who has recorded lux values at the face and also the sole author to employ the IGDT paradigm, both of which are associated with significantly higher reporting of illusions. An important aim of the current review is to encourage wider investigation of the strange face illusion, which we believe has relevance for researchers interested in understanding broader questions relating to perceptual instability, illusions, and hallucinations. Reviewing a decade of primarily phenomenological studies, it would seem pertinent now to move more toward experimentally assessing how environmental and behavioural manipulations impact the phenomenology within this paradigm and even the psychophysics of this complex illusion. Several new findings emerged from our systematic review and *meta*-analysis. The reporting rate for the illusion was related to demographic (age and gender) and methodological variables (paradigm type, whether lux was measured at the face, IGDT versus MGT paradigms), with overall study quality being the strongest predictor of strange face illusion prevalence. To date, studies have focussed on relatively young, predominantly female samples. These findings indicate that future high-quality studies assessing a wider sampling of participants to include older, more gender-balanced, samples would aid examination of the illusion and its implications. Examining susceptibility to the illusion in older individuals should be contextualised by the fact that poorer low light vision in older individuals may also play a role in increasing rates of strange face illusions. An important new finding from the current review has been that the rates at which the illusion is reported differs significantly across the two paradigms. To date only four studies have employed the IGDT (Caputo, 2013, 2015, 2017, 2019) and so, requires further examination. In this context, the exploratory factor structure (Caputo, 2019) of the SFI questionnaire has been examined only in relation to data derived from the IGDT, and should be extended to see if a comparable factor structure exists for data derived from the far more frequently examined MGT. Finally, it is important to develop a robust method to capture and characterise both the temporal and phenomenological dynamics in such a way that will allow independent assessment of illusory phenomena that appear to be mechanistically distinct (i.e., feature distortions vs new strange faces).

5. Conclusion

The present systematic review and *meta*-analysis shows that strange face illusions are a robust phenomenon, being reported by almost 60 % of non-clinical participants, although significantly more commonly in the dyad than mirror-gazing paradigm. The prevalence rate is strongly related to study quality and the experience of illusions appears to depend upon three key study design aspects (low light levels, a fixation instruction and face stimuli) that induce various face-related illusions ranging from feature distortions on the actual face through to the emergence of new faces. Further research is required to establish the mechanisms underpinning strange face illusions.

Conflict of interest statement

The authors declare that there is no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.concog.2023.103480.

References

Antczak, D., Lonsdale, C., Lee, J., Hilland, T., Duncan, M. J., del Pozo Cruz, B., et al. (2020). Physical activity and sleep are inconsistently related in healthy children: A systematic review and meta-analysis. *Sleep Medicine Reviews, 51*, Article 101278.

Beck, J., & Harris, M. J. (1994). Visual hallucinosis in non-delusional elderly. *International Journal of Geriatric Psychiatry, 9*(7), 531–536.

Billino, J., Hamburger, K., & Gegenfurtner, K. R. (2009). Age effects on the perception of motion illusions. *Perception, 38*(4), 508–521. https://doi.org/10.1068/p5886

Bremner, J., Krystal, J., Putnam, F., Southwick, S., Marmar, C., Charney, D., et al. (1998). Measurement of dissociative states with the Clinician-Administered Dissociative States Scale (CADSS). *Journal Of Traumatic Stress, 11*(1), 125–136. https://doi.org/10.1023/a:1024465317902
Brewin, C., Ma, B., & Colson, J. (2013). Effects of experimentally induced dissociation on attention and memory. *Consciousness And Cognition, 22*(1), 315–323. https://doi.org/10.1016/j.concog.2012.08.005
Brewin, C., & Mersaditabari, N. (2013). Experimentally-induced dissociation impairs visual memory. *Consciousness And Cognition, 22*(4), 1189–1194. https://doi.org/10.1016/j.concog.2013.07.007
Campos, J. L., El-Khechen Richandi, G., Taati, B., & Keshavarz, B. (2018). The Rubber Hand Illusion in Healthy Younger and Older Adults. *Multisensory research, 31*(6), 537–555. https://doi.org/10.1163/22134808-00002614
Caputo, G. (2010a). Strange-Face-in-the-Mirror Illusion. *Perception, 39*(7), 1007–1008. https://doi.org/10.1068/p6466
Caputo, G. (2010b). Apparitional experiences of new faces and dissociation of self-identity during mirror gazing. *Perceptual And Motor Skills, 110*(3C), 1125–1138. https://doi.org/10.2466/pms.110.3c.1125-1138
Caputo, G. (2011). Mask in the Mirror: The Living Mask Illusion. *Perception, 40*(10), 1261–1264. https://doi.org/10.1068/p7089
Caputo, G. (2013). Strange-face illusions during inter-subjective gazing. *Consciousness And Cognition, 22*(1), 324–329. https://doi.org/10.1016/j.concog.2012.08.007
Caputo, G. B. (2014). Archetypal-imaging and mirror-gazing. *Behavioral sciences (Basel, Switzerland), 4*(1), 1–13. https://doi.org/10.3390/bs4010001
Caputo, G. (2015). Dissociation and hallucinations in dyads engaged through interpersonal gazing. *Psychiatry Research, 228*(3), 659–663. https://doi.org/10.1016/j.psychres.2015.04.050
Caputo, G. B. (2016). Empathy and mirror-gazing. In D. F. Watt, & J. Panksepp (Eds.), *Psychology and neurobiology of empathy* (pp. 377–398). New York, NY: Nova Science Publishers.
Caputo, G. (2017). Strange-face Illusions During Interpersonal-Gazing and Personality Differences of Spirituality. *EXPLORE, 13*(6), 379–385. https://doi.org/10.1016/j.explore.2017.04.019
Caputo, G. (2019). Strange-face illusions during eye-to-eye gazing in dyads: Specific effects on derealization, depersonalization and dissociative identity. *Journal Of Trauma & Dissociation, 20*(4), 420–444. https://doi.org/10.1080/15299732.2019.1597807
Caputo, G. (2021). Split-mirror gazing increases dissociative states and illusions of self-identity. *Journal Of Trauma & Dissociation, 22*(3), 394–405. https://doi.org/10.1080/15299732.2020.1869642
Caputo, G., Ferrucci, R., Bortolomasi, M., Giacopuzzi, M., Priori, A., & Zago, S. (2012). Visual perception during mirror gazing at one's own face in schizophrenia. *Schizophrenia Research, 140*(1–3), 46–50. https://doi.org/10.1016/j.schres.2012.06.029
Caputo, G., Bortolomasi, M., Ferrucci, R., Giacopuzzi, M., Priori, A., & Zago, S. (2014). Visual Perception during Mirror-Gazing at One's Own Face in Patients with Depression. *The Scientific World Journal, 2014*, 1–4. https://doi.org/10.1155/2014/946851
Caputo, G., Lynn, S., & Houran, J. (2020). Mirror- and Eye-Gazing: An Integrative Review of Induced Altered and Anomalous Experiences. *Imagination, Cognition And Personality, 40*(4), 418–457. https://doi.org/10.1177/0276236620969632
Davis, M. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal Of Personality And Social Psychology, 44*(1), 113–126. https://doi.org/10.1037/0022-3514.44.1.113
Demartini, B., Nisticò, V., Tedesco, R., Marzorati, A., Ferrucci, R., Priori, A., et al. (2020). Visual perception and dissociation during Mirror Gazing Test in patients with anorexia nervosa: A preliminary study. *Eating And Weight Disorders - Studies On Anorexia, Bulimia And Obesity, 26*(5), 1541–1551. https://doi.org/10.1007/s40519-020-00977-6
Derome, M., Fonseca-Pedrero, E., Badoud, D., Morosan, L., Van De Ville, D., & Lazeyras, F. et al. (2018). Resting-State Networks of Adolescents Experiencing Depersonalization-Like Illusions: Cross-sectional and Longitudinal Findings. *Schizophrenia Bulletin*, *44*(suppl_2), S501-S511. doi: 10.1093/schbul/sby031.
Derome, M., Fonseca-Pedrero, E., Caputo, G. B., & Debbané, M. (2022). A Developmental Study of Mirror-Gazing-Induced Anomalous Self-Experiences and Self-Reported Schizotypy from 7 to 28 Years of Age. *Psychopathology, 55*(1), 49–61. https://doi.org/10.1159/000520984
Doherty, M. J., Campbell, N. M., Tsuji, H., & Phillips, W. A. (2010). The Ebbinghaus illusion deceives adults but not young children. *Developmental science, 13*(5), 714–721. https://doi.org/10.1111/j.1467-7687.2009.00931.x
Downes, M., Brennan, M., Williams, H., & Dean, R. (2016). Development of a critical appraisal tool to assess the quality of cross-sectional studies (AXIS). *BMJ Open, 6*(12), e011458.
Fonseca-Pedrero, E., Badoud, D., Antico, L., Caputo, G., Eliez, S., Schwartz, S., & Debbane, M. (2015). Strange-Face-in-the-Mirror Illusion and Schizotypy During Adolescence. *Schizophrenia Bulletin*, *41*(suppl 2), S475-S482. doi: 10.1093/schbul/sbu196.
Fu, R., Gartlehner, G., Grant, M., Shamliyan, T., Sedrakyan, A., Wilt, T. J., et al. (2011). Conducting quantitative synthesis when comparing medical interventions: AHRQ and the Effective Health Care Program. *J Clin Epidemiol., 64*(11), 1187–1197.
Greenland, S., & Robins, J. (1994 Apr 15). Invited commentary: Ecologic studies—biases, misconceptions, and counterexamples. *American journal of epidemiology., 139*(8), 747–760.
Greenland, S., & O'rourke, K. (2001 Dec 1). On the bias produced by quality scores in meta-analysis, and a hierarchical view of proposed solutions. *Biostatistics., 2*(4), 463–471.
Higgins, J. P. T., López-López, J. A., Becker, B. J., Davies, S. R., Dawson, S., Grimshaw, J. M., et al. (2019). Synthesising quantitative evidence in systematic reviews of complex health interventions. *BMJ Global Health, 4*, e000858.
Hirst, R. J., Setti, A., Kenny, R. A., et al. (2019). Age-related sensory decline mediates the Sound-Induced Flash Illusion: Evidence for reliability weighting models of multisensory perception. *Sci Rep, 9*, 19347. https://doi.org/10.1038/s41598-019-55901-5
Horton, R. (2002 Jun 5). The hidden research paper. *Jama., 287*(21), 2775–2778.
Ioannidis, J. P. (2007 Apr 1). Limitations are not properly acknowledged in the scientific literature. *Journal of clinical epidemiology., 60*(4), 324–329.
Hsieh, P. J., & Tse, P. U. (2009). Feature mixing rather than feature replacement during perceptual filling-in. *Vision research, 49*(4), 439–450.
Jackson, C., Jr, & Pollard, J. C. (1966). Some nondeprivation variables which influence the" effects" of experimental sensory deprivation. *Journal of Abnormal Psychology, 71*(5), 383.
Jenkinson, P., & Preston, C. (2017). The 'not-so-strange' body in the mirror: A principal components analysis of direct and mirror self-observation. *Consciousness And Cognition, 48*, 262–272. https://doi.org/10.1016/j.concog.2016.12.007
Jung, C. G. (1991). *The Archetypes and the Collective Unconscious (Collected Works of C.G. Jung)* ((2nd ed.).). Routledge.
Jüni, P., Witschi, A., Bloch, R., & Egger, M. (1999 Sep 15). The hazards of scoring the quality of clinical trials for meta-analysis. *Jama., 282*(11), 1054–1060.
Kissler, J., & Clementz, B. A. (1998). Fixation stability among schizophrenia patients. *Neuropsychobiology, 38*(2), 57–62. https://doi.org/10.1159/000026517
Komatsu, H. (2006). The neural mechanisms of perceptual filling-in. *Nature reviews neuroscience, 7*(3), 220–231.
Lange, R., Caputo, G., Lynn, S., & Houran, J. (2022). Mirror- and eye-gazing perceptions in advanced psychometric perspective: Preliminary findings. *Psychology Of Consciousness: Theory, Research, And Practice*. doi: 10.1037/cns0000328.
Li, Y., Xu, Y., Xia, M., Zhang, T., Wang, J., Liu, X., et al. (2016). Eye Movement Indices in the Study of Depressive Disorder. *Shanghai archives of psychiatry, 28*(6), 326–334. https://doi.org/10.11919/j.issn.1002-0829.216078
Manor, B. R., Gordon, E., Williams, L. M., Rennie, C. J., Bahramali, H., Latimer, C. R., et al. (1999). Eye movements reflect impaired face processing in patients with schizophrenia. *Biological psychiatry, 46*(7), 963–969. https://doi.org/10.1016/s0006-
Möllmann, A., Hunger, A., Dusend, C., van den Hout, M., & Buhlmann, U. (2019). Gazing at facial features increases dissociation and decreases attractiveness ratings in non-clinical females - A potential explanation for a common ritual in body dysmorphic disorder. *PloS one, 14*(7), e0219791.
Möllmann, A., Hunger, A., Schulz, C., Wilhelm, S., & Buhlmann, U. (2020). Gazing rituals in body dysmorphic disorder. *Journal Of Behavior Therapy And Experimental Psychiatry, 68*, Article 101522. https://doi.org/10.1016/j.jbtep.2019.101522
Mullin, H., Norkey, E. A., Kodwani, A., Vitevitch, M. S., & Castro, N. (2021). Does age affect perception of the Speech-to-Song Illusion? *PloS one, 16*(4), e0250042.
Nisticò, V., Caputo, G., Tedesco, R., Marzorati, A., Ferrucci, R., Priori, A., et al. (2020). Dissociation during Mirror Gazing Test in psychogenic nonepileptic seizures and functional movement disorders. *Epilepsy & Behavior, 112*, Article 107368. https://doi.org/10.1016/j.yebeh.2020.107368

Page, M., McKenzie, J., Bossuyt, P., Boutron, I., Hoffmann, T., Mulrow, C., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *PLOS Medicine, 18*(3), e1003583.

Pick, S., Rojas-Aguiluz, M., Butler, M., Mulrenan, H., Nicholson, T., & Goldstein, L. (2020). Dissociation and interoception in functional neurological disorder. *Cognitive Neuropsychiatry, 25*(4), 294–311. https://doi.org/10.1080/13546805.2020.1791061

Raine, A. (1991). The SPQ: A Scale for the Assessment of Schizotypal Personality Based on DSM-III-R Criteria. *Schizophrenia Bulletin, 17*(4), 555–564. https://doi.org/10.1093/schbul/17.4.555

Rogers, S., Keogh, R., & Pearson, J. (2020). Hallucinations on demand: The utility of experimentally induced phenomena in hallucination research. *Philosophical Transactions Of The Royal Society B: Biological Sciences, 376*(1817), 20200233. https://doi.org/10.1098/rstb.2020.0233

Rugens, A., & Terhune, D. B. (2013). Guilt by dissociation: Guilt primes augment the relationship between dissociative tendencies and state dissociation. *Psychiatry research, 206*(1), 114–116. https://doi.org/10.1016/j.psychres.2012.09.010

Shin, G., Goldstein, L., & Pick, S. (2019). Evidence for subjective emotional numbing following induced acute dissociation. *Behaviour Research And Therapy, 119*, Article 103407. https://doi.org/10.1016/j.brat.2019.05.004

Troxler, D. (I. P. V.). (1804). K. Himly & J. A. Schmidt (Eds.) "Über das Verschwinden gegebener Gegenstände innerhalb unseres Gesichtskreises" [On the disappearance of given objects from our visual field]. Ophthalmologische Bibliothek (in German), *2*(2), 1–53.

Wright, A., Fowler, D., & Greenwood, K. (2018). Developing a dynamic model of anomalous experiences and function in young people with or without psychosis: A cross-sectional and longitudinal study protocol. *BMJ Open, 8*(11), e022546.