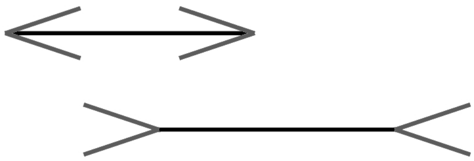
Is holistic (face) processing decisional ?

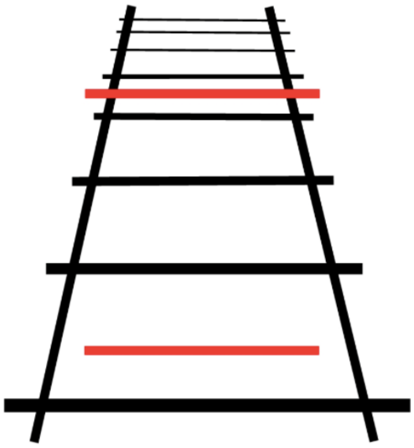
Contributed by Bruno Rossion, May 2013

Here are two well-known visual illusions: on the left the most common form of the Müller-Lyer illusion, and on the right the Ponzo illusion.



Müller-Lyer illusion

(Müller-Lyer, 1889)



Ponzo illusion

(Ponzo, 1911)

In both cases, two lines that are the same are perceived as being different.

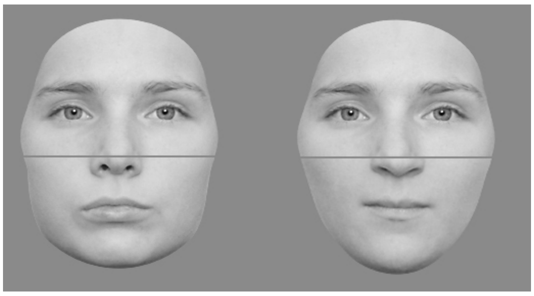
In the *Müller-Lyer illusion*, the fins can point inwards to form an arrow "head" or outwards to form an arrow "tail". The line segment forming the shaft of the arrow with two tails (below) is perceived to be longer than that forming the shaft of the arrow with two heads (above).

In the *Ponzo illusion*, the upper line looks longer because we interpret the converging sides according to linear perspective as parallel lines receding into the distance. In this context, we interpret the upper line as though it were farther away, so we see it as longer.

If you ask people to decide whether the two lines are identical, they will mistakenly answer “*no, they are different*”. It would never cross your mind that they perceive the lines as being identical and that their answer “different” comes merely from response-related, decisional processes. The two illusions reflect perceptual phenomena, which can drive incorrect behavioural responses when one needs to take a binary decision (‘same’ or ‘different’) about this percept.

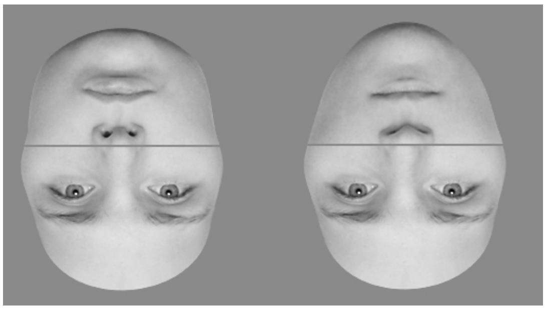
The composite face illusion

The exact same reasoning can be applied to face halves in the composite face illusion: two identical top halves of a face are perceived as being different when they are aligned with different bottom halves.



If you ask people to decide whether the two top halves are identical, they will often mistakenly answer "*no, they are different*". This phenomenon is attributed to the fact that the top and bottom halves fuse to form a novel whole face configuration (Young et al., 1987). The two whole configurations are different. We cannot isolate the line from its context in the Müller-Lyer and Ponzo illusions, and here we cannot isolate the top face half from the bottom half.

Like the Müller-Lyer and Ponzo illusions, it is our past experience with such stimuli, here faces, that make us see the two top halves of the composite faces as being different. Vision is an interpretation of the reality based on our previous experience (Gregory, 1997). This can be illustrated by simply flipping the face upside-down: now it is clear that the two "top halves" of the face (at the bottom of the images) are the same. Given that your visual system does not have prior experience with inverted faces, it does not interpret the two halves as being erroneously different.



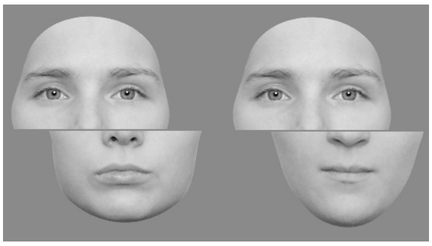
The sources of confusion regarding "decisional factors" of holistic processing

Given these compelling observations, one may wonder why some authors have attributed holistic face processing, in particular the phenomenon of the composite face effect, to *decisional* rather than *perceptual* factors ?

This misinterpretation originates from several sources.

First, following Hole (1994), experimental psychologists have inserted the composite face illusion in a behavioural "same/different" task, in order to obtain an objective measure of the percept. If people press "different" instead of "same" in the task, they take the wrong decision. While it seems obvious that this incorrect decision is driven by an incorrectly *perceived* difference, one cannot exclude that that observer correctly perceived the two halves as being identical but pressed the wrong response key, for whatever reason. For instance, the observer may systematically choose the wrong response key because he/she prefers a particular response key, or he/she wants to please/annoy the experimenter.

That is, the source/locus of a given behavioural response can potentially be located at any stage between the input and the output (sensory, perceptual, memory, attention, decision, motor response, etc.). This is the reason why there needs to be a control condition in the experiment. In the composite face paradigm, one typically compares performance to aligned and misaligned face halves, because the two top halves are not perceived as being different when they are misaligned with their respective bottom halves.



Note that a higher proportion of mistakes for aligned as compared to misaligned trials could still be due to decisional factors: irrespectively of what he/she perceives, a participant could prefer a particular response button just for aligned and not for misaligned faces. However, there is no methodological confound in the design, and it is unlikely that many participants will behave this way. Thus, such decisional biases are unlikely to affect the general outcome of an experiment in the standard composite face paradigm, which compares aligned to misaligned faces.

The **second** source of misinterpretation is due to the fact that psychologists have developed sophisticated theoretical models and data analyses methods to attempt identifying such decisional biases in a given task.

For instance, in Signal Detection Theory (SDT, Green & Swets, 1966) the bias/criterion is sometimes considered as a 'response bias' or a 'decision bias', i.e., an effect of 'cognitive/decisional' nature, whereas the *d'* index would reflect 'true discriminability' (i.e., an effect of perceptual origin). However the bias could be as valid a measure as the *d'*, and have a perceptual basis. That is, SDT is agnostic about the origins of the bias, and cannot inform about the functional locus of an effect (i.e., perceptual, attentional, decisional/response, etc.). Indeed, biases of perceptual origin exist and are readily induced. For instance, the signature of the motion aftereffect, another visual illusion, in data analyzed with SDT is a 'response bias' (Nishida & Johnston, 1999).

A multidimensional generalization of signal detection theory, the general recognition theory (GRT, Ashby & Townsend, 1986), also claims to be able to isolate indexes in a behavioural measure that reflect perceptual or decisional effects. This approach has been applied to paradigms developed to measure holistic face processing, claiming that a substantial part of the effects obtained were due to decisional factors (Wenger & Ingvalson, 2002; 2003; Cornes, et al., 2011), in particular in a composite face matching task (Richler et al., 2008). However, even when response bias confounds are deliberately introduced in the task (see below), the approach is unable to dissociate perceptual or decisional effects (Mack et al., 2011). In fact, I suspect that applying this approach to a "same/different" paradigm with simple visual illusions such as the Müller-Lyer illusion would lead to the (erroneous) conclusion that decisional factors account substantially for the effect obtained.

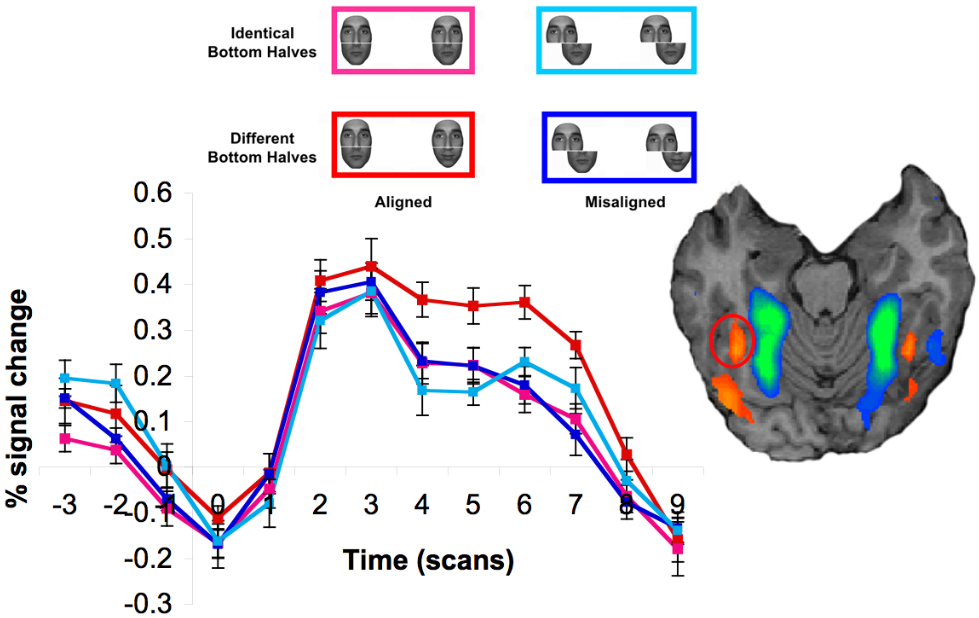
A **third** source of misattribution of holistic processing to decisional factors comes from the introduction of a response confound in the task. Following Farah et al. (1998), several authors have transformed the standard composite face paradigm in a *congruency paradigm* in which the top and bottom halves are associated with *congruent* (both "same" or both "different") or *incongruent* (one "same", the other "different") behavioural responses (Bukach & Gauthier, 2007; Richler et al., 2008).

This is a reinterpretation of the paradigm in the context of a Stroop or an Eriksen paradigm, in which one dimension is associated with a motor output X and another dimension with the same motor output X ("congruent") versus a conflicting motor output Y (MacLeod, 1991). In such studies with composite faces, the effect obtained could be partly or even entirely due, indeed, to decisional factors. That is, the two halves of the face would be processed completely independently until the response has to be given. At this stage, congruent trials would lead to better performance than incongruent trials because each half is associated with the same motor output as opposed to conflicting outputs (see "*The measure of an illusion of the illusion of a measure?"*).

However, even if decisional biases indeed contribute to the effect obtained in this paradigm, one cannot conclude from such effects that "holistic face processing is decisional" (Richler et al., 2008). Indeed, such decisional conflicts can be observed for dimensions that have nothing to do with each other, and cannot be treated in a holistic manner.

Composite face effects without a behavioural same/different response (bias)

Because of the perceptual illusion of seeing different whole faces, face-sensitive areas of the visual cortex show a release from adaptation, as compared to conditions in which the bottom halves are identical (Schiltz & Rossion, 2006).



The composite face paradigm as used in fMRI (Schiltz & Rossion, 2006). In the right fusiform face area

('FFA'), there is release from adaptation when the top halves are perceived as being of a different face identity (aligned with different bottom halves), a large effect compared to the 3 control conditions.

This release from adaptation is absent when the two halves are spatially misaligned. Interestingly, this neural composite face effect is obtained whether participants have to match the faces – leading to a response bias of perceptual origin (Schiltz et al., 2010) - or perform an orthogonal task, without any response bias (Schiltz & Rossion, 2006).

Similarly, top halves of faces with different aligned bottom halves produce larger N170 amplitudes than the same top halves of faces with the same bottom halves, as early as 160 ms poststimulus onset (Jacques & Rossion, 2009). This study identifies the functional locus of the composite effect at the earliest face perception stage, suggesting that facial parts are not independently processed as face-like entities before being integrated into a holistic representation. These results can be obtained when participants do not even provide a behavioural motor output on the critical trials (identical top halves with different bottom halves; Kuefner et al., 2010).

In summary, holistic face perception can lead to responses that are expressed in terms of decisional biases (pressing "different" for identical top halves). However, such decisional biases should not be interpreted as evidence for a decisional locus of holistic face processing. Holistic processing should not be reinvented as a general form of interference than can arise at any stage of processing of a system. It is a phenomenon, which needs to be understood in terms of neural mechanisms. Negating the percept, i.e. the phenomenon, or changing it to accommodate all possible forms of interference between visual dimensions, can only slow down this endeavour.

For a full discussion of this issue, please see the following paper:

Rossion, B. (2013). The composite face illusion: a window to our understanding of holistic face perception. *Visual Cognition*.

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