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Thompson's 1980 paper

[Thompson P, 1980 "Margaret Thatcher: a new illusion" *Perception* **9** 483 – 484. Original paper reprinted in the appendix.]

Author's update

The Thatcher illusion 28 years on ...

In 1980 my university, the University of York, was establishing an Electronics Department. In its first few years they had rather too many students and too few staff and the Department of Psychology kindly put on a course for their students. I had to give a couple of sessions for them; one was a simple signal-detection practical and another tried to show them that the visual system could be regarded as a crude Fourier Analyser. In the course of this latter enterprise I had tried to explain to them the 'missing fundamental' illusion (Campbell et al 1971)—as you move away from a square-wave grating with a missing fundamental, you should get to the point where the only visible component of the grating is the third harmonic, and then the grating should appear to have three times as many bars as it did when other harmonics were visible.

My daily walk from the car park (this was before I became a born-again cyclist) to my office required me to approach the window of a boiler-room on the ground floor of our building. The glass in this room was of a 'bathroom' variety, with vertical stripe to distort the view behind. For some reason the boilerman had pinned a page from a magazine onto this window. I don't know what was on the boiler-room side of the page; but on the reverse, facing outwards through the window, was the image of a scantily clad beauty. I happened to notice that, when viewed close to, even with one's nose pressed against the glass, the image was grotesquely distorted, but viewed from the car-park the image looked like, well, a scantily clad beauty. The reason was obvious enough: the glass acted to distort the high-spatial-frequency information in the picture but, at a great enough viewing distance, these frequencies are invisible anyway and only the undistorted low-spatial-frequency information was visible. This, I thought, would make a fine pedagogic tool, but I suspected that my class of electronics students would be unimpressed by this particular image, so I started thinking of constructing my own version of the picture.

My reasoning went like this. I need a very familiar image that will be instantly recognised by everyone. If I were to perturb this image in just its high-spatial-frequency content then such alterations would be readily apparent close-to but would be invisible from a distance. I decided a famous face might be a good candidate image so I dropped in to my local Conservative Association office. Margaret Thatcher had, the previous May, won the general election, defeating Jim Callaghan's Labour government which had been undone by the 'winter of discontent'. The smug officer I encountered in the party office was all too willing to let me have a couple of left-over posters from that election campaign. Once home I spread the two posters side by side on the floor and set about Margaret Thatcher with a razor blade. I cut out the eyes and mouth and inverted them, little knowing that I had just carried out the first 'Thatcherisation'. The effect was extremely pleasing: one of my posters looked wonderfully grotesque. I reasoned that if I showed my class both the undoctored image and the 'Thatcherised' image at a distance they would look identical but, as one approached, the true awfulness of one would become apparent. All I needed to do now was to stick the pieces of the Thatcherised image together. I left the room and went to collect some adhesive tape. When I returned I approached the side-by-side images where they lay on the floor. By chance they were arranged so they were upside down as I approached. And it was then

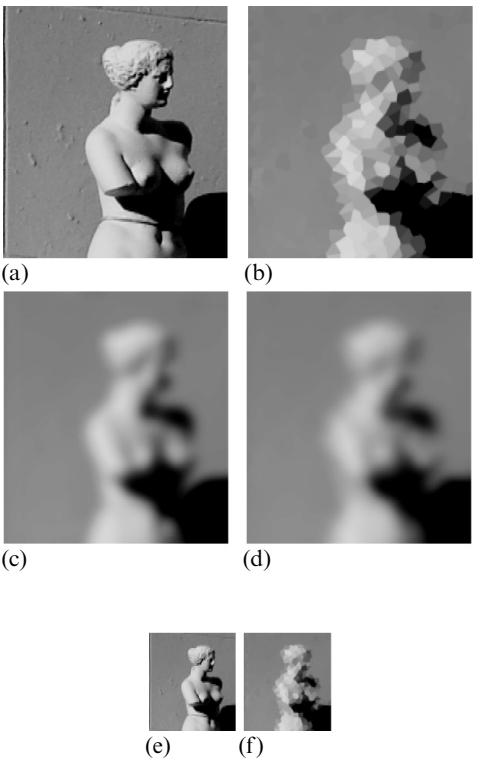

Figure 1. (a) A representation of the naked female form, though not the original image seen in the boiler-room. (b) The distorted appearance of the nude through the window of the boiler-room. (c) and (d) Low-pass-filtered versions of (a) and (b). Clearly the glass disrupts only the high spatial information of the figure. (e) and (f) Reduced versions of (a) and (b). This shows the effect of viewing the figure from a considerable distance. Again the distortion is not apparent but the figures now do not look so blurred.

I realised that the image that a couple of minutes previously had thrilled me with its awfulness, now looked happy and smiling.

I was pretty pleased with my chance discovery, and when I showed my posters to colleagues at work the next morning their reaction led me to think I was on to something. But what to do with the pictures? Back in 1980 I had never heard of configural processing; indeed face perception had yet to become the behemoth it is today. So one quick trip to the library later I penned a couple of hundred words, and popped it in the post to *Perception*. And the rest, as they say, is history.

Initially I thought the Thatcher illusion was just a bit of fun, until I had the privilege of spending time at an ARVO party with Irvin Rock. The great man clearly enjoyed the illusion; but, much more, he thought it illustrated something quite profound and indeed he convinced me of this fact. Unfortunately the next morning I couldn't remember what he had said. I do remember one comment from that night, though; Michael Morgan, eavesdropping our conversation, remarked that in years to come people will believe that Peter Thompson was a tyrannical prime-minister of the late twentieth century and that Margaret Thatcher was a minor psychophysicist. If only.

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Comments

Mrs Thatcher and the Bikini Illusion

Abstract. In 1980, Pete Thompson published his Mrs Thatcher illusion, one of the most astonishing and unexpected illusions of the century. It has been deservedly cited hundreds of times. The Mrs Thatcher illusion, together with upside-down smiles and upside-down bodies, can reveal selective breakdowns of configural versus featural processes in face perception.

Introduction

Peter Thompson is the name of the horse that won the Kentucky Futurity race of three-year-old trotters in 1911. It is also the name of the author of a celebrated little paper entitled "Margaret Thatcher: a new illusion" (Thompson 1980). This paper is very short but has been widely admired for its freshness and originality. A handy measure of an author's fame is the ratio of the words written about him to words written by him. For Shakespeare this ratio must stand at hundreds or thousands to one. This is also true for Thompson's paper. Although it is only 242 words long in its entirety, a quick click on Pubmed's 'Related Articles' yields no less than 120 references. So every word of Thompson's has inspired half an article. It is true that these form a wide-ranging collection, including:

Anon., 1968 "Porphyria and British royalty" *Medical Journal of Australia* March 16, **1**(11) 455 – 457 (no abstract available)
Cohen S G, Rizzo P L, 2001 "Asthma among the famous. Patrick O'Brian (1914 – 2000), British author" *Allergy and Asthma Proceedings* **22** 383 – 392 (no abstract available)
Payne D, 1998 "To Di for" *Nursing Times* **94**(34) 12 (no abstract available)
Sperati G, Felisati D, 2005 "Oscar Wilde (1854 – 1990)" *Acta Otorhinolaryngologica Italiana* **25** 381 (no abstract available)
Watson F, 1986 "The death of George V" *History Today* **36** 21 – 30 (no abstract available)
Wood A J, Maugham R J, 1999 "Famous sporting photographs: there's more than meets the eye" *British Journal of Sports Medicine* **33** 54 – 55 (no abstract available)
Young D A, 1995 "Florence Nightingale's fever" *British Medical Journal* **311** 1697 – 1700 (no abstract available)

This eclectic assembly suggested that Thompson's paper has offered more inspiration to those who do not understand vision than to those who do.

To create a Mrs Thatcher illusion, take a photo of a face. Carefully cut out the eyes and mouth, turn them upside down, and glue them back into place. This doctored face will look truly grotesque. But now turn the whole face upside down and it will no longer look grotesque. In fact, if this 'Thatcherised' face is put next to an un-doctored upside-down face, the two faces look about the same. It is only when they are both rotated into the upright position that the grotesqueness is noticeable. Peter Thompson has a 'Thatcherised' version of his own face on his web page at: http://www-users.york.ac.uk/~pt2/

His own upright face looks marginally more grotesque when the features within it are inverted, but inverting the whole inverted-feature face removes or hides the grotesqueness. I (Anstis 2005) published a feeble gloss on the Thatcher illusion, using photographic negatives instead of upside-down portraits.

The Thatcher phenomenon tells us something about the skills involved in face perception, which are tuned specifically to upright faces. Although faces are geometrically very similar, we are highly skilled at telling different individuals apart (especially of the same race as ourselves: Rhodes et al 2006). We probably achieve this by a combination of local featural processes, which deal with the details of individual facial features such as the mouth, nose, and eyes, and by global configural processes that deal with the structural relationship between individual features on the face, such as the spacing between the eyes, the fact that the eyes are above the mouth, and so on

(Bruce and Young 2000; Farah 1990). When a face is upside down, these configural processes do not work properly, so changes in the layout and orientation of the features are much harder to detect. The distinction between featural and configurational is somewhat arbitrary, in that the length of the philtrum (featural) has exactly the same meaning as the distance between nose and mouth (configural). Nevertheless the internal perceptual processes may be different.

The upside-down smile phenomenon

There is a problem with this loss-of-configural-perception theory. The fact that we fail to notice the grotesqueness of a Thatcherised face shows we are losing some of our capacities to process upside-down faces, but we certainly do not lose all of them; for example, we can see at a glance that there is something wrong with Prince Charles in figure 2, even upside down. Our skills may be tuned to upright faces, but which skills are lost as soon as a face is inverted, and which are conserved? I shall show that we still keep enough configural abilities to recognise the *smile* on an inverted face.

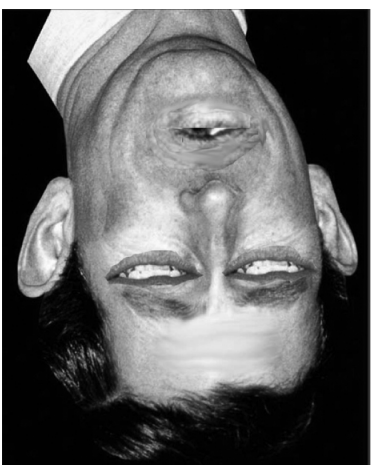

Figure 2. It takes very little configural processing power to recognise what is wrong with this upside-down portrait of Prince Charles.

The portrait of Mrs Thatcher in Thompson's article is smiling (it came from the York Conservative Office). Both the inverted and the Thatcherised faces look as though they are smiling, even though with respect to the Earth one mouth is upright and the other is inverted. This suggests that observers judge the mouth in isolation, not in the context of the face—in other words, that during inversion featural perception is preserved but configural perception is compromised. But how good are we at judging the expression on an inverted face? A smiling mouth turns up at the corners, but inverting the whole face made the mouth turn down, like a scowl. If we judge such an inverted face as smiling, we are responding to the configural context of the mouth. If we judge it as scowling, we are responding to the mouth in isolation. We examined this question by asking observers to judge the emotional expression on a variety of upright and inverted faces. We used 19 upright faces as foils. For the inverted faces we took 9 photographs of well-known politicians, including Tony Blair, and skilled actors, including Tony Blair. Some of these had neutral expressions with horizontal mouths, so two copies were made and the lips were warped in Photoshop in opposite directions, being bent upwards at the corners to give them an artificial smile or downwards for an artificial scowl. Some were originally smiling, so a warped copy was made with an artificial scowl; and vice versa. This gave us two very similar portraits of each celebrity, one smiling and one scowling. Each of these portraits was inverted (*not* Thatcherised).

This gave us 18 inverted faces, namely 9 individuals × 2 expressions. We presented the 37 photographs in random order, exposing each picture for 0.5 s. This brief exposure was designed to force the observer to form an immediate impression without the opportunity for second thoughts. The observer was asked to hit key '1' for Sad and '2' for Happy. After each keypress, there was a 2 s pause and the next picture was automatically presented. To avoid unwanted learning effects, the upright foils were different individuals from the inverted celebrities, to ensure that observers never saw any inverted photo in its upright orientation. Each observer gave approximately 100 responses, which included repetitions. Ten observers were run, all of them naive to the purpose of the experiment.

Results

Results were as follows. Observers correctly judged the expression on 92.4% of the upright faces. This was a control condition, and in an ideally designed experiment they would have scored 100%. They correctly judged the expression on 69.4% of the inverted faces, with scores by different observers ranging from 42.9% to 91.1% (chance would be 50%). In other words, in 7 cases out of 10 they successfully judged the expression given by the curvature of the mouth, not in isolation but in the context of the whole face. This indicates that we retain considerable powers to analyse inverted faces configurally.

Figure 3 shows line drawings of a smiling (a) and scowling (b) face. What expressions do you read on (c) and (d)? If you see c = sad, d = happy, you are making a featural judgment of the mouths in isolation. If you see c = happy, d = sad, you are making a configural judgment of the mouths in the context of the whole face, like 70% of our observers.

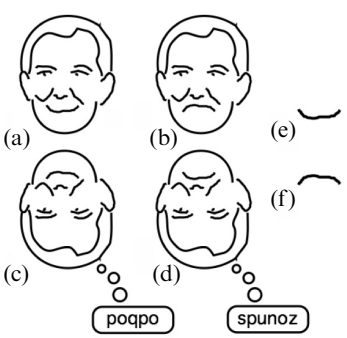

Figure 3. Four faces and six mouths. The only difference between (a) and (b) is the inversion of the mouth: (a) appears to smile, (b) to scowl. Before you turn the page around, what expressions do you read in (c) and (d)? In the isolated mouths in (e) and (f)? And what words do you read in the thought bubbles? See text.

The task of reading an inverted face is akin to the 'mental rotation' of 3-D shapes described by Shepard and Metzler (1971); and it would be interesting to know whether males enjoy the same advantage over females in perceiving inverted faces as they do in Shepard's task.

How do you perceive the isolated Cheshire Cat smiles or scowls in (e) and (f)? These mouths have no contexts, so you probably assume the default context of an upright face. However, if you have just been looking at (c) and (d), you might carry over the mental context of an inverted face. Lastly, what about the thought bubbles in (c) and (d)? If you read them as the nonsense words *poqpo*, *spunoz*, you are judging the words in isolation, that is, as they are printed on the page with respect to the Earth. If you read them as the antique swearwords *odbod*, *zounds*, then you are making a configural judgment, that is, you are 'mentally inverting' them in order to read them in the context of their attached faces. Chances are that you read them as *poqpo*, *spunoz*, in the way that they are printed, because there is a strong Stroop effect in which the overlearned response to the upright words as printed competes with, and overrides, the uncommon and laborious task of reading the words upside down.

In fact, a similar though weaker form of negative priming may apply to reading lips; when judging the expression of a friend or an enemy, we are likely to attend specifically to their mouth where the expressiveness is most highly concentrated. This could happen when viewing an inverted face such as figure 3c or 3d, and would be like looking directly at figures 3e or 3f. This response of isolating and responding to the mouth may compete with our attempts to read the whole upside-down face of (c) or (d).

The upside-down body phenomenon

What is true of faces may be true of bodies. Suppose you walk along the beach and you walk past somebody's head as they lie on the sand, so that you see them upside down as in figure 4. Look at figure 4 (without turning the page upside down) and see if you know who it is.

Figure 4. Before you turn the page upside down, can you identify this person? Now rotate the page and look.

Now turn the page around to see the person the right way up. OK, I was lying when I asked who it was. It's Halle Berry! I just wanted to distract your attention for long enough to demonstrate that the upside-down swimsuit is probably not noticed in the inverted portrait but is immediately obvious in the upright portrait. Therefore the Mrs Thatcher illusion is not confined to faces but also applies to this full-body figure 4, which I shall call the Miss Thatcher illusion. I wanted Dr Thompson to pose for figure 4 but regrettably he declined.

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The Thatcher illusion: Now you see it, now you don't

Thompson created his now-famous 'Thatcherised' face to test whether the eyes and mouth are important cues to facial expression (Thompson 1980). He was aware that expression and identity are harder to see in inverted (upside-down) faces and reasoned that expression should be preserved in an inverted face whose eyes and mouth remain upright, if the eyes and mouth were crucial. To test this hypothesis he presents an inverted Mrs Thatcher alongside a version whose eyes and mouth remain upright, and invites the reader to observe that "the transformation makes little difference to Mrs Thatcher's expression" (page 483). So far, so good. The eyes and mouth signal expression. But the fun part, beloved of Introductory Psychology teachers, occurs when the images are rotated 180°. Now, quite unexpectedly, Mrs Thatcher is accompanied by a grotesquely distorted sister, with a maniacal grimace! The effect also surprised and intrigued its creator (Thompson, this supplement), prompting him to suggest that, perhaps, with further study, it might reveal something important about face perception (as well as Margaret Thatcher).

Researchers have taken up the challenge with gusto, so that Thatcherisation refers not to the adoption of the erstwhile prime minister's policies, but rather to replications of Thompson's feature manipulation in other faces. Industrious researchers have puzzled over just why Thatcherisation produces its ghastly effect, why the effect is lost with inversion, and what it all means. This has led to hours of fun devising different ways to create grotesque expressions. Interestingly, not all kinds of grotesque expressions are lost with inversion, so the illusion is not simply due to insensitivity to expression in misoriented faces. Inversion has little effect on grotesque expressions posed by models or generated by tampering with features without misorienting them (eg reddening eyes and blackening teeth—Bartlett and Searcy 1993; Murray et al 2000; Searcy and Bartlett 1996). In contrast, inversion eliminates grotesque expressions created by Thatcherisation or by altering the distances between facial features (eg eyes apart and mouth down) (Bartlett and Searcy 1993). Perhaps, then, the loss of expression in inverted Thatcherised faces reflects difficulty coding spatial relations in misoriented faces (see also Anstis 2005).

This conclusion fits nicely into a longstanding theoretical framework in which configural coding of spatial relations, known to be highly sensitive to misorientation, is central to face expertise (Diamond and Carey 1986; Maurer et al 2002; Peterson and Rhodes 2003). So too does evidence that the Thatcher illusion is reduced in other-race faces (Murray et al 2003), for which expertise and configural coding are reduced (Hayward et al 2008; Rhodes et al 2006), and in children (Donnelly and Hadwin 2003), who are not yet face experts (Carey 1992; Mondloch et al 2003). So, Thatcherising a face seems to alter the spatial relations between the inverted features and the rest of the face, making the face look grotesque, and the effect is destroyed by inversion which makes these relations difficult to code.

But like all good mysteries, it seems that there is more to the story. Inversion effects are larger for Thatcherised faces than faces with other abnormal spatial relations (Bartlett and Searcy 1993; Rhodes et al 1993), suggesting that something more than sensitivity to spatial relations is important. We suggest that the inverted features themselves might also look odd, for several reasons. Because they are interpreted as upright features, their internal spatial relations will be odd. For example, the top eyelid normally covers more of the pupil than does the bottom eyelid, but this is reversed in a Thatcherised face. Also, if the teeth are visible (as in the smiling Mrs Thatcher), the inverted mouth will be perceived as upright with lower teeth bared, in a threatening growl ("grrr").

We also propose that the inverted eyes and mouth take on a sunken, ghoulish appearance, owing to an incorrect assumption about their direction of illumination. The visual system expects illumination from above, and interprets the shadows on a

3-D object as arising from convex and/or concave surfaces accordingly. This effect is dramatically illustrated in the hollow-face illusion, where a hollow (concave) face lit from below appears quite normal, because the visual system assumes that it is a normal (convex) face lit from above. In a Thatcherised face, which is assumed to be top-lit, the inverted eyes and mouth, whose lighting direction has actually been reversed, will appear concave and sunken—not a good look! If this explanation is correct, we should be able to achieve an extreme makeover of the Thatcherised face by making its inverted features look convex, and hence less alarming. This can be done by replacing the top-lit inverted features with ones from a bottom-lit face (figure 5c). To see if this works, consider the original face in figure 5 [on the left in pairs (a) and (b)], along with its Thatcherised version in pair (a) (right image) and its made-over version in pair (b) (right image). Turn the page upside down and look for the Thatcher illusion: now you see it [pair (a)] and now you don't [pair (b)]!

Almost 30 years on, the Thatcher illusion is travelling well, with over 50 citations in the last five years alone. While Margaret Thatcher herself may be 'old news' to the internet generation, the Thatcher illusion has lost none of its impact and intrigue. The illusion was posted on a website featuring visual illusions, along with the following caption, which deftly summarises our understanding of the illusion 30 years since its creation, "This has something to do with brain (sic) recognizing the faces ... am not sure how this illusion works, but it works!".

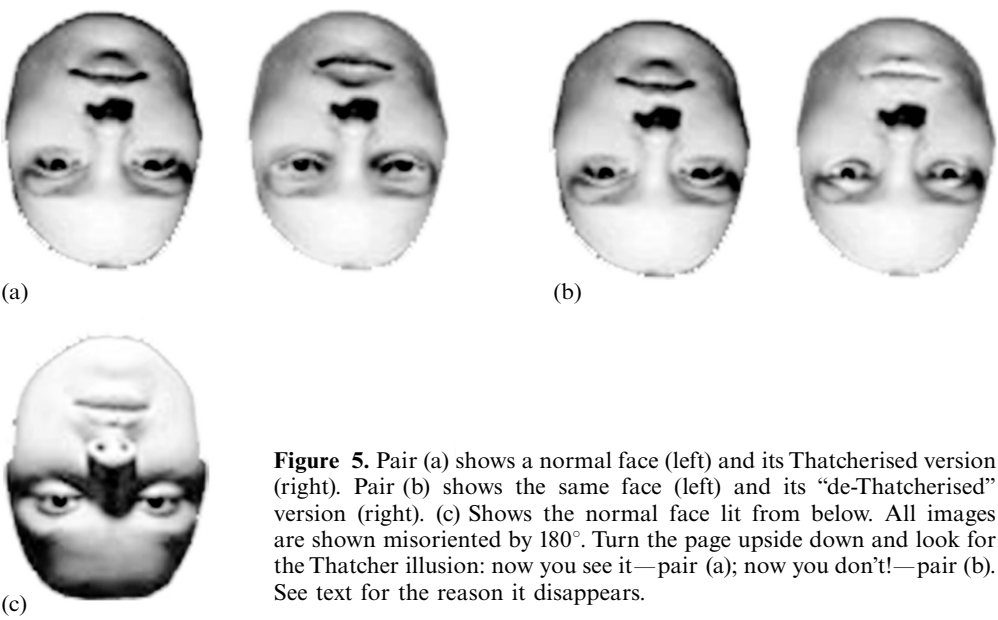

Figure 5. Pair (a) shows a normal face (left) and its Thatcherised version (right). Pair (b) shows the same face (left) and its "de-Thatcherised" version (right). (c) Shows the normal face lit from below. All images are shown misoriented by 180°. Turn the page upside down and look for the Thatcher illusion: now you see it—pair (a); now you don't!—pair (b). See text for the reason it disappears.

Acknowledgments. We thank Paddy McMullen for permission to 'Thatcherise' faces from her paper (McMullen et al 2000). Both authors are supported by the Australian Research Council. We thank Will Hayward for his comments on this comment.

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The enduring nature of the Thatcher illusion

While Peter Thompson was pressing his nose against the boiler-room window in York, I was an undergraduate student at the University of Manchester. At the beginning of my final year, I visited the library in search of some inspiration for a project. Browsing the current issues of *Perception* the title "Margaret Thatcher—a new illusion" caught my eye. The paper made an immediate impression. It was commendably short, well-illustrated, and entertaining. So a third-year project on recognising upside-down faces was born.

In the event, Thompson's illusion inspired not just a student project but a life-long interest for me. After graduating, I went to Nottingham University to do a PhD on face recognition. One experiment required stimuli for a task in which people decided whether a stimulus was a face. It was based on jumbled faces, in which the position of the eyes, nose, or mouth had been swapped. In those days 'cut and paste' required nothing more complicated than a pair of scissors and a tube of glue. I settled down one afternoon with a collection of photographs spread out on the kitchen table, and set about them with the scissors. After a while I walked around the table, which was in the middle of the kitchen, to switch the kettle on. Turning round and looking back at my handiwork, I was surprised to see the grotesque expression of the Thatcher illusion staring back at me. In this image I had swapped the position of the eyes and mouth but left them in their normal orientation. The grotesque expression only appeared when the face was viewed upside-down, rather than when only viewed upright as in Thompson's illusion. Parks (1983) had suggested that the Thatcher illusion was influenced by the orientation of "a familiar, encompassing frame" and demonstrated that an inverted letter is more prominent in upright text than it is in inverted text. The figure I had inadvertently created showed that the frame given by the external features of a face was irrelevant (Valentine and Bruce 1985).

Yin (1969) provoked interest in recognition of upside-down faces by suggesting that a disproportionate effect of inversion on face recognition was evidence that face recognition was a 'special' process (see Valentine 1988 for a review). The Thatcher illusion was influential in establishing the view that inversion disrupted processing of the configural properties of faces. As a result, inverted faces are routinely used as a control for the 'special' processing of configural information. By the end of the 1980s the debate on the status of face processing as a 'special' process appeared to have ended with a realisation that the answer rather depends on what is meant by 'special' (Ellis and Young 1989), only for it to re-emerge amongst cognitive neuroscientists as the expertise hypothesis (eg Gauthier and Bukach 2007). In contrast to the behavioural data, neuro-imaging data show only limited effects of inversion. Both upright and inverted faces provoke an N170, an event-related potential associated with face processing, although it is a little larger and a little slower for inverted faces (de Haan et al 2002). Inverted faces also strongly activate the fusiform face area, associated with processing upright faces (Kanwisher et al 1998).

Thompson (1980) has been cited over 150 times. Studies have shown that children, children with autism, and infants are sensitive to 'Thatcherisation' of faces (Bertin and Bhatt 2004; Donnelly and Hadwin 2003; Lewis 2003; Rouse et al 2004). The N170 is larger for upright Thatcherised faces than for normal faces but smaller for inverted Thatcherised faces (Carbon et al 2005). Reaction time to detect Thatcherisation gradually increases with increasing rotation from the upright (Lewis 2001) but the N170 shows a nonlinearity with orientation (Carbon et al 2005).

The ability of the Thatcher illusion to inspire has endured. I still show it in my introductory lecture on face processing, although no longer using Margaret Thatcher's face. It reliably provokes surprise, laughter, and buzz of conversation ... and students wanting to do a project on face processing.

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Author's response

I have been asked a number of times why it is that, while several people have published extensively on the Thatcher illusion, I was not tempted to jump on my own bandwagon. The answer is simple: I didn't understand why the effect occurred and I couldn't think of a really clever follow-up experiment. That is not to say that there haven't been clever experiments on the effect that I wished I had thought of—I certainly wished I had thought of Valentine and Bruce (1985). However, all these years later I still don't understand the effect; the usual explanation suggests that upside-down faces aren't really processed as faces and so we don't benefit from configural (or is it holistic?) coding.

The commentaries by Rhodes, Valentine, and Anstis are very kind; and in the case of Gill Rhodes, too kind. She suggests the Thatcher illusion was the result of a purposeful attempt on my part to test a hypothesis. Sorry. Not true. It was sheer luck, the sort of serendipity that can occur when you waste your time cutting up the faces of little-loved (in our household anyway) politicians.

Stuart Anstis has used his commentary to slip a quick experiment into the literature, one that shows that we can derive a good deal of information about the expressions of inverted faces, a fact well known from previous research (see the Rhodes commentary for references). And in true Anstis fashion he devises a new variant of the effect using a scantily clad female. His claim that I refused to pose for the picture is, of course, untrue—see my figure 6.

Tim Valentine's experiences with cutting up faces closely resemble my own; I needed some sticky tape, he wanted a cup of tea, but the result was the same: we came to look at things from a new angle and found something new. His commentary highlights the real value of the Thatcher illusion; it's not that we now understand more about face processing because of it, but rather we appreciate better how puzzling the problem is. Margaret Thatcher's face may have made us ask the question 'why?', and even if we still haven't the full answer, it's still probably the best thing she ever did for science.

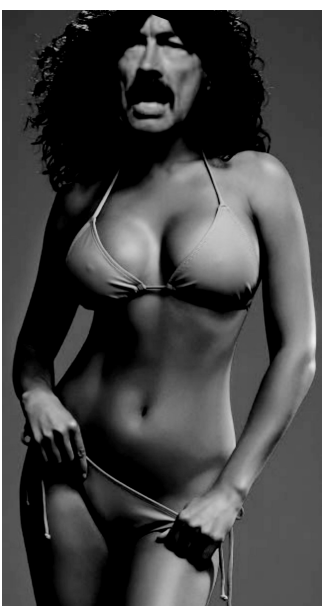

Figure 6.

I have often been asked why the effect occurs and have often recited the mantra of configural coding not being available when faces are turned upside down, but my heart isn't really in the explanation. I have this nagging doubt that if, upside down, we see the Thatcherised face's component eyes and mouth in an upright 'normal' expression, why doesn't an upside-down, non-Thatcherised Margaret Thatcher not look hideous? After all, her features are in the same orientation as the Thatcherised ones the right way up.

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