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Cultural Differences in Perception: Observations from a Remote Culture

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Abstract
Perceptual similarity was examined in a remote culture (Himba) and compared to that of Western observers. Similarity was assessed in a relative size judgement task and in an odd-one-out detection task. Thus, we examined the effects of culture on what might be considered low-level visual abilities. For both tasks, we found that performance was affected by stimuli that were culturally relevant to the tasks. In Experiment 1, we showed that the use of cow stimuli instead of the standard circles increased illusory strength for the Himba. In Experiment 2, only the Himba showed more accurate detection based on category differences in the displays. It is argued that that Categorical Perception in Experiment 2, based on its presumed Whorfian origins, was the more reliable procedure for examining the effects of culture on perception.

Keywords
Culture, categorical perception, Whorf, Ebbinghaus illusion, visual search

Similarity is an inherently unspecified notion with an infinity of ways that two objects may be decided to be similar (Goodman, 1972). Hence, we should not be surprised that different experiences, whether in the same or different cultures, promote similarity in different ways. Here we examine perceptual similarity in a remote culture and compare performance to the same stimuli by observers from our Western culture. We examine similarity in a size judgement task and in an odd-one-out detection task. Thus, we are examining what might be considered low-level visual abilities. Yet, we shall show that the experience of the remote tribe allows both of these tasks to be dealt with differently from Western observers. In so doing, we return to an old debate made important in the New Look movement in psychology (Bruner and Goodman, 1947) that basic perceptual processes can be influenced by our value systems. A

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recent similar proposal is to be found in Nisbett *et al.* (2001) where cultural variation is held to lead to differences in attention and to styles of thought.

The first task – to be used in Experiment 1 – is to judge the relative size of circles in a context which to Western observers leads to erroneous judgements. The standard context is that of a surround of circles which have the effect of making a central circle look smaller if the surround circles are bigger and to make it look larger if the surround circles are smaller (Ebbinghaus illusion, see Fig. 1). We have already recorded (De Fockert *et al.*, 2007) the remarkable accuracy of the Himba, a remote semi-nomadic African tribe, in judging the true sizes of circles in the Ebbinghaus illusion; indeed, the Himba experienced no illusion if the surround inducers were diamonds rather than circles. Other populations (e.g., autistic children, typically developing young children and men) have been reported with reduced Ebbinghaus illusion (Happé, 1996, but note the non-replication by Ropar and Mitchell, 1999; Hanischzak *et al.*, 2001; Kaldy and Kovacs, 2003; Phillips *et al.*, 2004) but none of these groups see as little illusion as the Himba (De Fockert *et al.*, 2007).

There are many factors that affect the strength of the Ebbinghaus illusion in Western observers (Rose and Bressan, 2002). One of those factors that seems relevant to the Himba performance is the distribution of attention across the display. Attentional variation as an explanation of the variation in illusory strength in geometric displays was proposed and verified by Pressey (1971, 1974) and Coren and co-workers (Coren and Girgus, 1972; Coren and Porac, 1983) and extended to illusions due to motion (Gogel and Tietz, 1976) and even to judgements of size constancy (Epstein and Broota, 1986). With respect to the Ebbinghaus illusion, Shulman (1992) found that attention modulated its strength if the observer was asked to perform another task concerning the colours of the surround circles. Where attention had to be paid to the surround circles to perform the second task, Western observers saw more illusion than when the surround circles were not relevant. Western observers will also pay more attention to the target central circle and, hence, see less illusion, if an unpleasant picture is placed on the target (van Ulzen *et al.*, 2008). So, Western observers can also concentrate their attention on the central circle in those circumstances. Clearly, there is something about the standard Ebbinghaus array that makes Western observers, but not the Himba, unable to pay attention solely to the central circles and hence group the whole display. In Experiment 1, we ask whether we could provide a type of stimulus that might cause a similar whole display grouping for the Himba. To this end, we make use of another aspect of the Ebbinghaus illusion in that it is also sensitive to the conceptual similarity of the elements.

Coren and Enns (1993) found that the Ebbinghaus illusion was stronger for conceptually similar items (e.g., dogs surrounded by other dogs rather

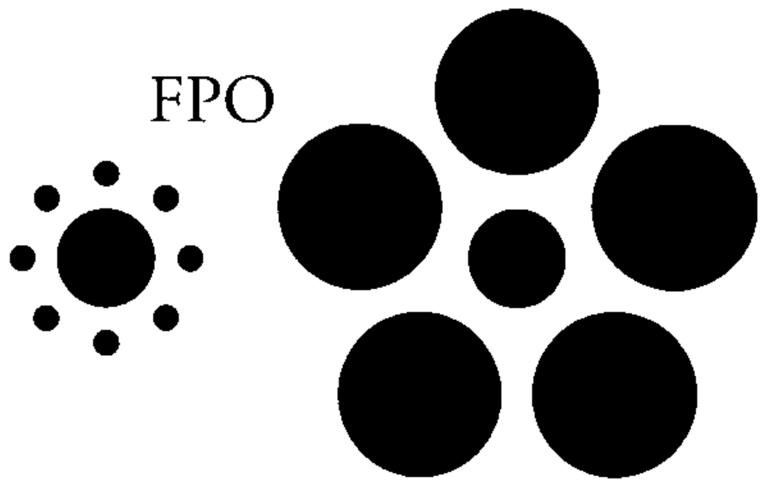

Figure 1. Circle Version of the Ebbinghaus illusion.

than shoes). Subsequently, it was found to be sufficient for the observers just to believe that the surround items (in this case faces) were from a different category than the central target face (Stapel and Koomen, 1997; Pickett, 2001). Stapel and Koomen (1997) found more illusion if the observers thought the faces were all from the same profession (e.g., lawyers) and Pickett (2001) if the faces were of people from the same social group. Our variation of the Coran and Enns (1993) effect of conceptual similarity was to replace the circles with silhouettes of cattle that were highly familiar and socially important to the Himba.

In Experiment 2, we will investigate a different aspect of similarity. We will ask whether conceptual similarity can make for a more accurate perceptual discrimination in a study of Categorical Perception (CP). Harnad (1987) provides a comprehensive discussion of CP across a range of auditory and visual categories. He argued that, with CP, a physical continuum is perceived as qualitatively discontinuous. Items from different categories appear more different than items from the same category despite being equated for physical difference (e.g., by numbers of just-noticeable-differences). CP is thereby revealed by faster and more accurate discriminations between stimuli that cross a category boundary than between two stimuli that are both good exemplars of the same category (Bornstein, 1987). Goldstone (1994) further argued that this between-category expansion might also be accompanied by a within-category compression where items within a category become to be perceived more similar. Perhaps the most well-known example of this within-category compression is that of Japanese speakers who lose the ability to discriminate between l and r sounds (Ingram and Park, 1998). As a technique, CP has been used to consider debates in face (Etcoff and Magee, 1992) and colour categorisation (Roberson, Davidoff and Braisby, 1999). In Experiment 2, we make use of the importance of cattle to demonstrate CP unique to the Himba.

The demonstration of CP for colour terms (Kay and Kempton, 1984; Davidoff, Davies and Roberson, 1999; Özgen and Davies, 2002) has been important in the considerable revival of interest in the Whorfian hypothesis (Whorf, 1956) that the language available to describe perceptual experience can influence the experience itself. Differences between languages in their grammatical structure and vocabulary have also been associated with perceptual differences of the same experience in other domains. For example, Whorfian explanations have been offered for effects of grammatical gender (Sera *et al.*, 1994, 2002, Boroditsky *et al.*, 2003); material and shape classification (Lucy, 1992); spatial relations (Levinson, 1996; Bowerman and Choi, 2001), number systems (Gumpertz and Levinson, 1996, Gordon, 2004), artifact categories (Malt and Johnson, 1998); modes of motion (Gennari *et al.*, 2000); time (Boroditsky, 2001) and shape (Roberson *et al.*, 2002). However, the Whorfian conclusion in these studies has been disputed with arguments against the influence of linguistic differences for mathematical abilities (Gelman and Butterworth, 2005), colour (Kay and Regier, 2003) and perceptual classification, both at the level of terminology (Malt *et al.*, 1999; Munnich and Landau, 2003) and grammatical structure (Karmiloff-Smith, 1979; Pérez-Pereira, 1991). The present study will not pursue that debate itself but rather provide further evidence that the Himba cattle categories promote CP in the Himba in conditions where it is not shown in Western observers.

By way of the rich Himba vocabulary of animal pattern terms, Goldstein and Davidoff (2008) assessed CP in the two-alternative forced-choice (2AFC) methodology used in most previous studies of colour (Roberson, Davies and Davidoff, 2000; Özgen and Davies, 2002). In the 2AFC, the observer is asked to identify the exact stimulus (target) previously presented where the alternative choice is either from the same or a different category. CP is shown if decisions are more accurate when the foil is from a different rather than the same category. As both foils are the same perceptual distance from the target, the effect must be due to experience (presumably through naming) warping the perceptual space. One potential and serious artifact with the 2AFC design (Munnich and Landau, 2003) is that of explicit naming whereby, it could be argued, superior recognition memory could be achieved as a result of matching by name. The same argument about labelling could be made if the 2AFC task were replaced by similarity judgements from a small number of simultaneously presented alternatives (Roberson *et al.*, 2000). It is possible to rule out explicit naming by use of interference procedures (Roberson and Davidoff, 2000) but these are not possible with a Himba population. Probably a better technique would have been to employ a visual search task under rapid visual presentation that would make naming difficult (Gilbert *et al.*, 2006); this is the technique to be used in Experiment 2.

The Himba

The studies were carried out with the Himba who are a semi-nomadic population of animal herders estimated between 20 000 and 50 000 (Namibian Govt. statistics, 2004) whose territory is spread over an area of some twenty-five thousand square miles, in northern Namibia and Angola. They inhabit an arid region; their visual diet is of open desert, scrubland and mountain. The Himba speak a dialect of Herero but, unlike that group, have retained a strong and distinctive traditional cultural identity that brings little contact with other cultures. See Crandall (2000) and Bollig and Schulte (1999) for accounts of the Himba as a distinct, cohesive cultural and linguistic group where cattle are a critical part of their culture. Eckl (2000) and Turton (1980) for an Ethiopian group of cattle herders with similar life-style to that of the Himba, outline cultural interests and reasons why colour and patterns are used to recognise both individual animals and categories. For example, Eckl (2000) notes that social organization (patrilocal and matrilocal clans) are designated by different cattle patterns. Therefore, it is not surprising that the Herero and Himba have many names and considerable interest in categories of cattle patterns (Eckl, 2000).

Experiment 1: Circle and Cow Versions of the Ebbinghaus Illusion

Our previous research has shown that Himba show very little illusion with the standard (circle) version of the Ebbinghaus illusion (De Fockert *et al.*, 2007). Here we wish to see whether the Himba might see more illusion if the circles were replaced by silhouettes of cows that are culturally relevant and therefore may more likely cause grouping across the display.

Method

Participants

Participants were twenty three (11 men) adult monolingual Himba from an isolated region in Northern Namibia (mean estimated age 25 years 1 month, range 19–35 years). Their language contains no words for geometric shapes, like circles and squares. Twenty four further participants (12 men) were native English speakers (mean age 24 years 4 months, range 19–38 years). The English participants were undergraduate students from Goldsmiths' College and were paid or validated course credits. The Himba were rewarded in kind. No cases of abnormal vision were reported.

Stimuli – Circle Version

Stimulus configurations were presented in black on a white computer screen and consisted of a central target circle surrounded by inducing stimuli, which were large or small circles (see Fig. 1). The centre-to-centre distance between the target and each inducer was 32 mm for the large inducers and 16 mm for the small inducers. Two side-by-side stimulus configurations were presented simultaneously to participants. In the Small Inducers configuration, circle inducers were presented with a diameter of 5 mm diameter, and the size of the central target circle remained constant at 19 mm diameter. In the Large Inducers configuration, circle inducers were presented with 32 mm diameter, and the target diameter ranged from 17.66 mm to 22.15 mm, with 0.66 mm steps. Thus, there were two figures (17.66 and 18.32 mm) in which the target circle in the Large Inducers condition was smaller than the target circle in the Small Inducers condition (Target Size Difference – 1.32 and – 0.66 mm, respectively), one figure in which the two targets were equal in size (Target Size Difference 0 mm), and five figures in which the target circle in the Large Inducers condition was the larger one (Target Size Difference 0.66, 1.32, 1.98, 2.64, 3.30 mm). Thus, relative to the target in the Small Inducers condition of 19 mm, the size of the target circle in the Large Inducers condition was 93.1%, 96.5%, 100%, 103.5%, 106.9%, 110.4%, 113.9% and 117.4%, respectively. The asymmetry in the stimulus set makes use of the fact that a reverse illusion does not normally occur (large inducers will seldom produce the illusion of a larger target). So, some conditions in a symmetrical array would be highly redundant. It also has the advantage that the middle stimulus is not the veridical. Thus, neither random performance nor any strategy based on the range of target sizes in the Large Inducers condition, will lead to veridical performance.

Stimuli: Cow Version

Stimulus configurations for the cow version of the Ebbinghaus illusion are shown in Fig. 2 and were created on the same basis as the circle version with each cow picture fitted to what would be the centre of the circle. All the other details remained identical.

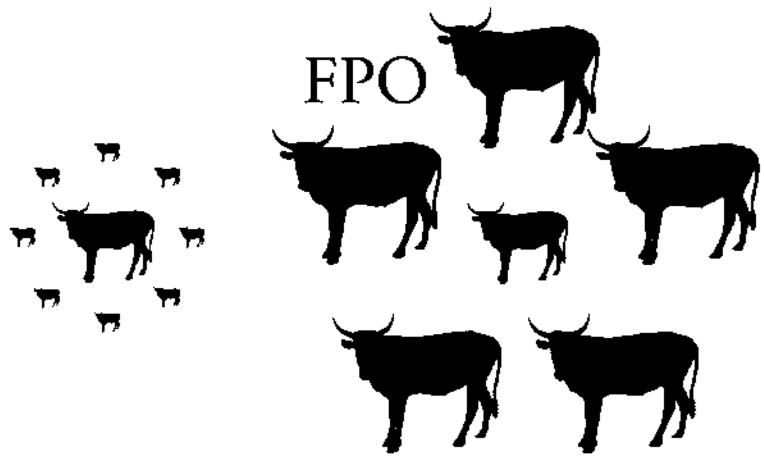

Figure 2. Cow Version of the Ebbinghaus Illusion.

Procedure

Blocks of eight practice trials were administered in which the participant simply saw two circles, one of which varied in diameter from 17.66 to 22.15 mm and the other remained constant at 19 mm. Participants were instructed to indicate the larger circle by answering on a two-button response box: left button if they thought the left circle was larger or right button for the right circle. Training continued until they reached 75% accuracy within a block. All participants needed only one block of practice trials, except for one Himba who could not reach criterion (75% accuracy) and whose data were not further analysed.

After training, participants were presented with a block of 48 test trials for each inducing shape condition (circles or cows, order counterbalanced across participants), each consisting of five randomly distributed trials of each target size in the Large Inducers configuration (ranging in size from 17.66 to 22.15 mm) presented together with a Small Inducers configuration. Within each block and within each target size in the Large Inducers configuration, the Small Inducers target was equally likely to occur on the left or on the right of the display. The instructions were given with the help of a naive interpreter for the Himba participants. Viewing distance was approximately 60 cm. During the test, participants received no feedback on the accuracy of their response.

Results

To analyse performance on the illusion, we first calculated the target circle size for each participant that made the two central circles look equal; this is called the point of subjective equality (PSE). We fitted the data using the inverse cumulative distribution for a standard normal distribution to estimate each participant's threshold for deciding that the Variable target was the larger one. The following model was fitted to each participant's data from the Circle and Cow conditions: $P = \varphi(z)((k-d)/\sigma)$ where P is probability of choosing the Variable Target, $\varphi(z)$ is the inverse cumulative distribution function for a standard normal distribution, k is the required threshold for deciding that the Variable Target is the larger one ($k = 0$ means no illusion, positive k values indicate illusion), d is the difference between the radius of the two circles (in mm) and σ is the standard deviation of the normally distributed noise, combined for the perceptual process (associated with the perceived difference in size between the two targets) and the decision process (normally distributed variability in the placement of the decision criterion).

For each participant, the PSE was entered into a 2 (Culture: English, Himba)×2 (Inducer Shape: Circles, Cows) ANOVA with repeated measures over the second factor.

There was a main effect of Culture ($F(1,45) = 39.35$, $P<0.00001$ (Greenhouse-Geisser corrected); $\eta_p^2 = 0.467$) with the Himba seeing less illusion: on average, the 19 mm Constant Target was seen the same size as a 20.769 mm Variable Target by the English, and as a 19.629 mm Variable Target by the Himba. There was also a main effect for Inducer Shape ($F(1,45) = 60.64$, $P < 0.00001$; $\eta_p^2 = 0.574$) with the circle producing more illusion than the cows: on average, the 19 mm Constant Target was seen the same size as a 20.610 mm Variable Target in the Circle condition, and as a 19.788 mm Variable Target in the Cow version. There was a significant interaction between Culture x Inducer Shape ($F(1,45) = 15.50$, $P < 0.0003$; $\eta_p^2 = 0.256$). Analysis of the interaction with Tukey (HSD) post hoc tests showed that the there was much more reduction in illusion strength from Circles to Cows for the English participants ($P < 0.0001$) compared to the Himba ($P < 0.007$) (see Fig. 3). To examine the finding in Phillips *et al.* (2004) of greater illusion in females, we added Gender as an extra factor in the analysis. However, there was no main effect of Gender ($F < 1$) and no interactions with Gender (all P values >0.11).

To examine whether, as in De Fockert *et al.* (2007), any variation in the illusion reduced its strength to zero, we conducted an analysis of the differences of PSEs from veridicality. It revealed that both cultures experienced the illusion

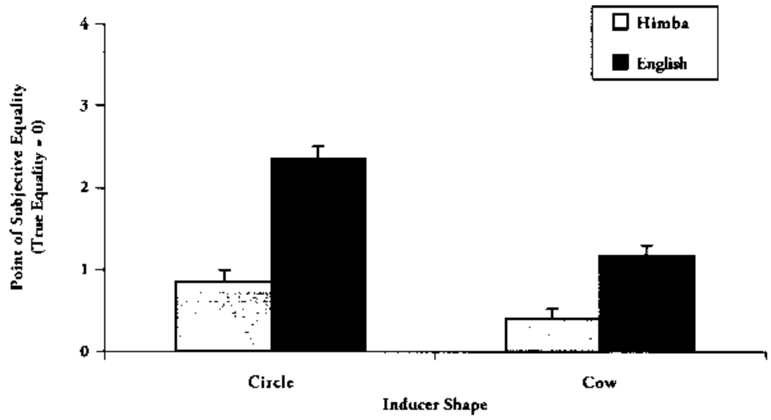

Figure 3. The Point of Subjective Equality (PSE) for Himba and Western observers in the Circle and Cow versions of the Ebbinghaus illusion.

with both Inducer Shapes: Circle inducer (for the English $t(23) = 14.62$, $P < 0.0001$, for the Himba ($t(22) = 8.63$, $P < 0.0001$); Cow inducer (for the English $t(23) = 9.14$, $P < 0.0001$, for the Himba ($t(22) = 3.71$, $P < 0.001$).

As in De Fockert *et al.* (2007), in order to directly test that overall size judgment accuracy was indeed greater in the Himba than in the English, we looked at how often the veridically larger target was selected by each participant, irrespective of whether this target was the constant or variable one, and calculated the overall accuracy score for each participant. Trials in which the Variable target size was identical to that of the Constant target (19 mm) were excluded from this analysis, since there was no correct answer here. For each participant, the judgment accuracy was entered into a 2 (Culture: English, Himba)×2 (Inducer Shape: Circles, Cows) ANOVA with repeated measures over the second factor.

There was a main effect of Culture ($F(1,45) = 16.58$, $P < 0.0001$ (Greenhouse-Geisser corrected); $\eta_p^2 = 0.269$): The size judgments were significantly more accurate for the Himba (mean proportion correct = 0.85) compared to the English (mean proportion correct = 0.68). There was also a main effect for Inducer Shape ($F(1,45) = 22.04$, $P < 0.00001$; $\eta_p^2 = 0.329$). The size judgments were significantly more accurate for the Cow version (mean proportion correct = 0.82) compared to the Circle version (mean proportion correct = 0.71). There was a significant interaction between Culture×Inducer Shape ($F(1,45) = 40.74$, $P < 0.0001$; $\eta_p^2 = 0.475$). Analysis of the interaction with

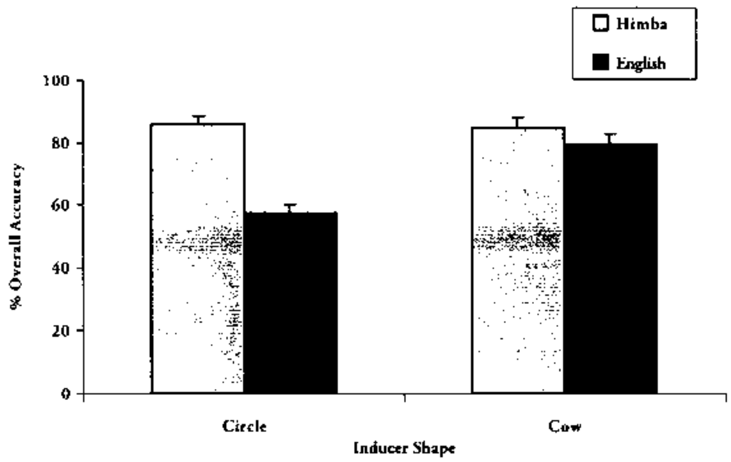

Figure 4. The accuracy of relative size judgements for the Himba and Western observers in the Circle and Cow versions of the Ebbinghaus Illusion.

Tukey (HSD) post hoc tests showed that English participants were more accurate in the Cow version compared the Circle Condition ($P < 0.0001$), whereas there was no difference in accuracy for the Himba ($P > .93$) (see Fig. 4).

Discussion

Experiment 1 replicated the finding in De Fockert *et al.* (2007) that the Himba are more accurate in relative size judgements in the standard (Circle) version of the Ebbinghaus illusion. We first ask how this finding relates to the influential theory proposed by Nisbett *et al.* (2001). They proposed a cultural origin for difference in attention and cognition between Western and East Asian populations. Westerners are deemed to have more analytic cognition and East Asians more holistic cognition. Thus, when inspecting displays, there have been convincing demonstrations that East Asians pay attention to more of the displays than do Westerners (Ji *et al.*, 2000; Masuda and Nisbett, 2001; Nisbett and Miyamoto, 2005). There is even data to show that Japanese students are more susceptible to the Ebbinghaus illusion than UK students (Doherty *et al.*, submitted). While the present study does not provide a systematic test of the cultural effects on attention proposed by Nisbett *et al.* (2001), the data here do not appear to correspond to predictions that might be made from that hypothesis.

According to Nisbett, the origins of the attentional and cognitive differences between Westerners and East Asians come from their different social systems. It is proposed that the collectivist East Asian culture promotes attention to more of displays because those cultures implicitly seek alternative views in their interactions and so the whole context of any display could be relevant to any task or argument. The individualistic Western culture promotes attention to the objects in displays and thereby leads to an analytical, rule-based view of the world (Nisbett *et al.*, 2001). The historical analysis of the origins of these two styles is held to come from past agrarian East Asian cultures where collective decisions are important for crop production compared to the herding economy that pre-dated the rise of Ancient Greece which promoted the individualistic thought of which we are the inheritors in Western societies.

The pattern of behaviour observed in the Ebbinghaus illusion in De Fockert *et al.* (2007) and here in Experiment 1 ought to mean that the Himba should be highly individualistic but there is no obvious supporting evidence. They live in a social community where roles and behaviour appear to be rigidly enforced. Even their hairstyles and body jewellery are not a matter of choice but prescribed by their position in the group. Furthermore, their limited technology would not characterise their society as analytic as no more would their limited belief in the type of personal agency that led to scientific advance. Crandall (2000) writes that the Himba believe "that much of life is beyond our control" (p. 211). However, the Himba are a herding culture with, in comparison to a Kenyan nomadic group, "reasoning… more in correspondence to Western science" (Bollig and Schulte, 1999, p. 511). So, there may yet be some support for Nisbett's thesis but it is very difficult to believe that the Himba would have a more analytic cognition than Westerners and give this as the sole explanation for their extreme accuracy in the Ebbinghaus illusion. In asking for an explanation for their lack of susceptibility to the Ebbinghaus illusion, we find it more convincing to look within their culture for aspects that make for a default mechanism to look for detail. For example, previous investigations of their sorting behaviour have shown that, for the Himba, small differences become overly important to them in both shape and colour tasks (Roberson *et al.*, 2002; 2005).

We next consider a methodological issue that might concern any interpretation of our data. The Himba showed less illusion than the UK sample and it might be thought that it was simply the use of computer screens and button pressing as techniques that disadvantaged the Himba. However, it is important to stress that only a full understanding of the instructions could produce the result of greater accuracy. Moreover, we do not believe that asking the Himba to press a button to respond was stressful and, much to our initial surprise, the use of a computer screen for stimulus presentation was not something that caused the Himba concern. Performance in the Circle condition of

Experiment 1 was the same as in De Fockert *et al.* (2007) where the stimuli were presented on paper though it could be argued that this medium was equally unfamiliar. In any case, concerns about unfamiliarity with the test apparatus turn out, for the most part, to be unwarranted from recently conducted studies using computers where performance showed the same pattern of performance as Western controls (Lescroat *et al.*, submitted); the concerns even turn out to be unwarranted for young Himba children (Daoutis *et al.*, 2006).

In De Fockert *et al.* (2007), the Himba showed no illusion when the circle inducers were changed to diamonds. Turning to the culturally relevant inducers used in Experiment 1, we find a somewhat different effect with respect to the Cow inducers. The Himba experienced an illusory effect in the Cow inducer condition to the same extent as they did for the Circle condition. It would appear that the cultural relevance of the cattle stimulus allowed greater binding of the parts of the configuration as does conceptual similarity for Western observers (Coren and Enns, 1993; Stapel and Koomen, 1997). One might be cautious of that explanation given the overall lower susceptibility of the Himba to the illusion but Himba performance levels for the Circle condition were the same in this study as in De Fockert *et al.* (2007). So, clearly it could have been possible for the Cow inducers to have produced an equivalent drop in performance as that found for the diamond inducers in De Fockert *et al.* (2007) but they did not.

Experiment 2: Categorical perception in visual search

In their paper on the role of affective stimuli in changing the strength of the Ebbinghaus illusion, van Ulzen *et al.* (2008) cast their data in the historical context of the New Look movement in perception (Bruner and Goodman, 1947). In that movement, experimental evidence was put forward in favour of the alteration of perceptual processes (e.g., size judgements) by the observer's values. However, the results of those experiments were not easily reproduced and became interpreted as reflecting response biases rather than a true alteration to perception (Jenkin, 1957; Tajfel, 1957). In many ways similar has been the debate concerning the Whorfian hypothesis and Experiment 2 employs a task that has been used within that debate.

In Experiment 2, we ask whether the Himba might detect a visually discrepant item in a display more quickly because the discrepancy conforms to a categorical distinction important to their culture. Here, we are not directly concerned, as we were in Goldstein and Davidoff (2008), whether the origin of the categorical distinction is from the speaker's language terms but more to gain further purchase upon the idea that value systems might influence perception. Indeed, CP by definition implies what the New Look movement were hypothesising, namely that the observer's perceptual space has been modified by experience.

Method

Participants

Participants were eighteen (12 men) adult monolingual Himba from an isolated region in Northern Namibia (mean estimated age 27 years 3 months, range 17–43 years). Thirty six further participants (11 men) were native English speakers (mean age 23 years 6 months, range 18–41 years). The English participants were undergraduate students from Goldsmiths' College and were paid. The Himba were rewarded in kind. No cases of abnormal vision were reported.

Stimuli

Full details of the preparation of the cattle stimuli can be found in Goldstein and Davidoff (2008). In essence, a continuum of pictures was produced that morphed one cattle pattern into another. The end-points of the continuum were a pattern called Ongange (white spots on body and face) and another called Omvahe (cream colour). Pictures of the animals were isolated from their context/background, manipulated in Adobe Photoshop and given a light yellow background, approximating the colour of the earth/sand of the Himba territory (see Fig. 5). To ensure that the animal shape was identical for both end-points, the same silhouette was used for both endpoints. The pictures were manipulated in the Meditor morphing package to produce a continuum. The continuum consisted of 21 pictures in total with a 5% difference between each morphed picture going from one endpoint to the other. Thirty different Himba from those that had provided the cattle names were then asked to give a name to all the intermediary stimuli produced by the morphing process.

There was a sharp drop in the continuum where the name given to one endpoint changed to the name given to the other endpoint. As these intermediary points represent 'imaginary' animals, one might ask why there is not a gradual change from one name to the next rather than a sudden change. The most likely answer is that we have chosen prototypical animals for the endpoints. Animals with the same name would bear a strong family resemblance to the prototype, and the morphing procedure would move, in a few images, from pictures that would easily be named as the endpoint to ones that would not be so named.

The boundary was assessed by eye to be between pictures 12 and 13 (see Fig. 6). Eight pictures were chosen from the continuum to give two pairs of

Figure 5. The endpoints of the continuum used in Experiment 2. These stimuli were morphed to provide a continuum of stimuli separated by a 5% difference.

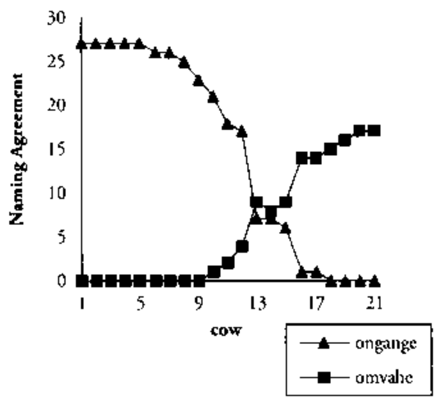

Figure 6. Himba naming agreement to the morphed stimuli.

stimuli that were from the same category and two pairs of stimuli that were from different categories. There was always a 10% morph distance between the two pictures in each pair (see Fig. 7). These pairs of stimuli were used to produce the visual search displays. The stimuli were printed on cards with 8 stimuli on each card; 4 in a column to the left of centre and 4 in a column to the right of centre. Each of the 8 cow pictures on a card was 5 cm wide and 4 cm high. On each card, 7 pictures were identical and one picture was different. The odd-one-out picture was randomly situated in the displays and either from the same category as the seven identical pictures or from a different cattle pattern category.

Procedure
Stimuli were presented on printed cards rather than on a computer screen because of the inadequacies of lap-top monitors. On lap-tops, stimuli of vary-

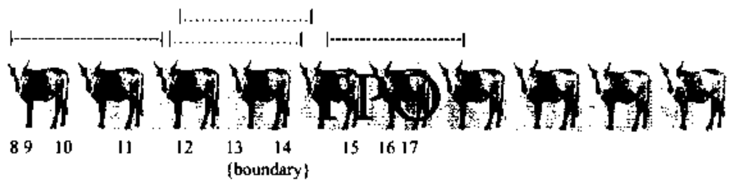

Figure 7. A section of the morphed continuum from which pairs of between-category and within-category pairs were chosen for use in the visual search task. Within-category pairs are pictures 8,10 and 15,17. Between-category pairs are pictures 11,13 and 12,14.

ing contrast appear with brightness differences according to the angle of view. With the subtle differences used in this study, head restraint would have been required to ensure proper stimulus control and this was considered unacceptable for the Himba population. As stimuli were presented by hand, it was decided to show them for 3 seconds as this was found in pilot studies to be the shortest time for which the experimenter could be reliable. Pilot studies suggested that the task was going to be difficult for Western observers so two groups of these were recruited one to be tested with same presentation time (3 seconds) as the Himba and another group given longer (5 seconds).

All participants were first given practice trials with cards for which it was immediately obvious which cow was different to the other identical seven. They were instructed to give their answer by simply indicating with a tap of the left or right hand on the table whether the different stimulus lay on the left side or the right side. Training consisted of 4 cards to which all the participants answered correctly. After training, participants were presented with 16 cards; half where the odd-one-out was from the same category and the other half where the odd-one-out was from a different category. For the Himba, instructions were given with the help of a naive interpreter. During the test, participants received no feedback on the accuracy of their response. Himba participants and a first group (n = 18) of English participants performed the task with 3 seconds exposure per card. A second group of controls (n = 18) performed the task with 5 seconds per card.

Results

A 2 (Culture: Himba vs. English 3 seconds vs. English 5 seconds)×2 (Condition: Between-Category vs. Within-Category Trials) ANOVA, with repeated measures on the second factor, was carried out on the accuracy data. Results (see Fig. 8) showed that the main factor of Culture was significant ($F(1,51)$ =

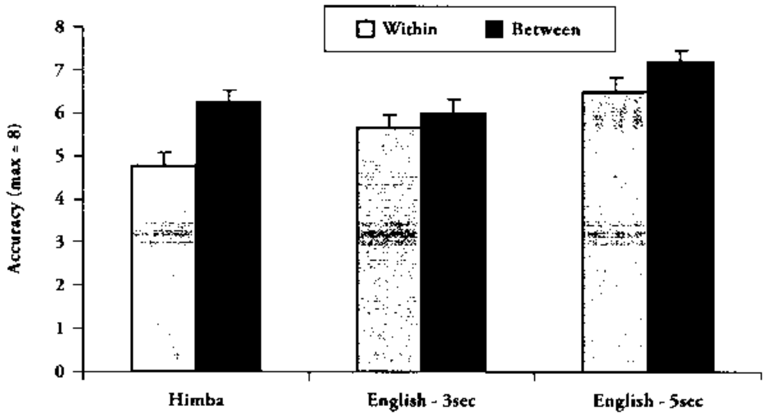

Figure 8. Accuracy for Himba and two groups of Western controls in the visual search task.

8.19, $P < 0.001$; $\eta_p^2 = 0.243$) due to the English 5 seconds group making fewer errors (mean = 6.86) compared to both the English 3 seconds group (mean = 5.83, $P < 0.01$) and the Himba (mean = 5.50, $P < 0.01$). There was a main effect of Condition ($F(1,51) = 21.23$, $P < 0.00001$; $\eta_p^2 = 0.29$) with overall higher accuracy for the Between condition (mean = 6.48) compared to the Within condition (mean = 5.64) but there was a significant interaction between Culture×Condition ($F(2,51) = 3.24$, $P < 0.04$; $\eta_p^2 = 0.11$). Analysis of the interaction with Tukey (HSD) post hoc tests showed that it was only the Himba participants who were more accurate for the Between-Category condition compare to the Within-Category condition ($p < 0.0005$). There was no difference between conditions for the two English groups (3 seconds: $P = 0.89$ and 5 seconds: $P = 0.21$, respectively; see Fig. 8).

Discussion

It turned out that the Western undergraduates did not find the task, on average, harder than did the Himba given the same exposure time. In fact, given longer than the Himba to inspect the figures, Western undergraduates were more accurate. However, it was only the Himba observers who showed a superiority of search where the odd-one-out target was from a different category. Thus, the visual search experiment gives rather clear evidence that experience in some form has altered the Himba perception of the cattle patterns. They see two cows as more dissimilar than we do if those cows are from different categories.

General Discussion

Two experiments were presented that gave evidence in favour of what the New Look movement in psychology were proposing in the 1940s (Bruner and Goodman, 1947; Bruner and Postman, 1948), namely, that perception can be changed by the value system of the observer. The first experiment was on size judgements and was more similar to those conducted in the New Look cycle of studies. However, it must be admitted that another similarity is that the size of the culturally caused effect is not large. The change of the standard Ebbinghaus stimuli using geometric circle patterns to the culturally valued one using cow silhouettes did not produce a strong illusion for the Himba. It did have a significant effect but it was a relatively small one. A much stronger effect of culture was found in Experiment 2 where qualitatively different patterns of performance were found between Western and Himba observers.

There are good reasons for Experiment 2 to have produced larger effects of culture than Experiment 1. The estimation of size, especially relative size, will depend primarily on basic visual mechanisms that are the same for the Himba as Western observers. Indeed, De Fockert *et al.* (2007) found that changes to the visual similarity of the inducers (circles to diamonds) produced equal effects in both cultures. So, effects in the Ebbinghaus illusion due to conceptual similarity do not have the opportunity to produce large variations in perception. While it is also true that detecting differences in cattle patterns depends on basic visual mechanisms, there is something different about having the added benefit of CP. After having acquired CP, the perceived differences in similarity have become the norm, or what one might describe as the default procedure, for making perceptual comparisons.

Take the case of judgements of colour differences. Of course, there is an underlying neurophysiology that can be used to assess colour difference but after having acquired CP, the colour space becomes warped so that the default setting is to see colours from the same category as more similar. As the English speaking observers in Kay and Kempton (1984) responded when asked how they carried out an odd-one-out colour task, "the colours just look different". The implicit nature of these categorical judgements of colour differences is shown in the neuroimaging study of Fonteneau and Davidoff (2007). Observers were asked to respond whenever they saw a cartoon character embedded within a rapid succession of colours. Event related responses (ERPs) to a colour depended on whether that colour was embedded within colours from the same or different categories. None of the observers realised that the experiment concerned colour judgements, yet the colour differences were automatically responded to according to the colour categories of the observer. The ERPs to a categorical colour difference occurred earlier than to a physically equal colour difference from the same category; this corresponds to categorical differences being perceived as more different.

It does not matter whether the colour differences in Fonteneau and Davidoff (2007) or the cow pattern differences for the Himba derive from language terms or whether from extensive experience of simply treating the colour exemplars (or cow patterns) as examples from the same category. Under both explanations, considerable experience is required to establish CP. So, the categorical similarity becomes the default procedure for assessing similarity and therefore a more reliable way of assessing cultural effects on perception.

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