Urbanisation Decreases Attentional Engagement

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September 2012

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Abstract

Exposure to the urban environment has been shown dramatically to increase the tendency to process contextual information. To further our understanding of this effect of urbanisation, we compared performance on a local-selection task of a remote people (the Himba) living traditionally or relocated to town. We showed that (i) spatial attention was defocused in urbanised Himba but focused in traditional Himba (Experiment 1) despite urbanised Himba performing better on a working-memory task (Experiment 3), (ii) imposing a cognitive load made attention as defocused in traditional as in urbanised Himba (Experiment 2), and (iii) using engaging stimuli/tasks made attention as focused in urbanised Himba (and British) as in traditional Himba (Experiments 4 and 5). We propose that urban environments prioritise exploration at the expense of attentional engagement and cognitive control of attentional selection.

Keywords: attention, selection, engagement, cognitive control, cognitive load, working memory, alertness, stress, urbanisation, culture
Many of the world’s peoples have become urbanised over the past hundred years and it is estimated that 69% will live in urban areas by 2050 (Dye, 2008). As urbanisation has accelerated, its perceptual implications have been documented with not least the assertion by Jung (1933; 2001) that remote people are better at concentrating on the task in hand. More empirical historical work has given us simple comparisons between westerners and remote peoples showing that westerners have an increased tendency to process contextual information and to show susceptibility to contextual illusions (Rivers, 1905; Segall, Campbell, & Herskovits, 1963). More recently, a more direct connection to urbanisation showed that while remote people displayed little Ebbinghaus size-contrast illusion these same people relocated to town displayed the same substantial illusion as British observers although still less than Japanese observers (Caparos, Ahmed, Bremner, De Fockert, Linnell, & Davidoff, 2012).

There has been remarkably little work on how urbanisation comes to exert these effects since the pioneering work of Gregory (e.g., 1966;1998). One exception is recent work showing that exposure to a cluttered visual scene makes global changes more detectable than local ones (Miyamoto, Nisbett, & Masuda, 2006) and it might be tempting to explain the urbanisation differences in susceptibility to contextual illusions as resulting from a clutter-induced global bias or tendency to prioritise the perceptual processing of global information. However, this account would suggest that urbanisation imparts a selective advantage in the processing of global information which turns out not to be the case (Caparos, Linnell, De Fockert, Bremner, & Davidoff, in press). Here we consider two alternative explanations which are instead compatible with Jung’s (1933; 2001) assertion that remote peoples are better at concentrating.

The first explanation derives from another recent study showing that exposure to urban environments decreases working-memory or cognitive capacity and with it the cognitive control of behaviour in accordance with task demands (Berman, Jonides & Kaplan, 2008). Given that decreased cognitive control decreases the ability to constrain spatial attention (Caparos & Linnell, 2010; Linnell & Caparos, 2011) and that spatial attention gates long-range perceptual interactions (Freeman, Sagi, & Driver, 2001), the decreased cognitive control with urban exposure would explain the increased processing of contextual information. Specifically, Berman et al. (2008) argued that the impaired ability to ignore contextual information in those living in urban environments arises because these environments exert higher cognitive load than natural environments. Thus, urban environments, in all their diversity and unpredictability, deplete working-memory or cognitive resources, whereas natural environments allow these resources to replenish and thus restore cognitive-control function. Indeed, even a “walk in the park” was proposed to restore cognitive function in urbanised participants.

A second alternative is that urbanisation differences in the ability to ignore contextual information are explained by differences in the engagement, rather than in the availability, of cognitive resources. Indeed, engagement differences provide a parsimonious explanation of the effect on spatial attention of several other factors including perceptual load (Linnell & Caparos, 2011) and level of interest in the task (Suzuki, Nittono, & Hori, 2004). For example, Linnell and Caparos (2011) showed that having cognitive resources available in a task of local selection is not enough to focus spatial attention; perceptual difficulty also needs to be high and this is arguably because it increases attentional engagement on the task and thus the deployment of cognitive resources. Attentional engagement may also vary depending on how
appropriate it is to environmental conditions. On the one hand, in conditions that prioritise sustained interaction with task-relevant objects such as prey or tools, attentional engagement is necessary; on the other hand, in conditions that prioritise exploration and the search for potential dangers or new opportunities, attentional engagement is counter-productive or even dangerous (McGilchrist, 2010; Singh-Curry & Husain, 2009). The latter conditions are arguably more frequent in urban environments which in turn may decrease attentional engagement.

In sum, the difference between the cognitive-load and attentional-engagement accounts of urbanisation is that, according to the former, cognitive resources are depleted and therefore not available whereas, according to the latter, cognitive resources are available but not engaged.

All the experiments reported here were run on the Himba, a remote cattle-herding people living in the open bush of north-west Namibia (Crandall, 2000; for pictures see Biederman, Yue, & Davidoff, 2009). The Himba lead a secure and self-sufficient existence, having no natural predators or competitors and rarely if ever experiencing crime or want. As in Caparos et al. (2012), we compared Himba living traditionally with Himba who had had the same traditional upbringing but who had relocated in early adulthood to the only town in the region (Opuwo). Opuwo expanded after Namibian independence in 1990 and its inhabitants now lead a largely western existence. Our rationale for studying these different Himba communities was (1) that urbanisation should differ more between them than between rural and urban communities most anywhere in the world, and (2) that comparing them should provide a good control for inheritance, upbringing, language, and climate, amongst other factors.

We started by testing assumptions common to the cognitive-load and attentional-engagement accounts of urbanisation before proceeding to test assumptions that discriminate between them. A first assumption, common to both accounts of increased processing of contextual information is that, in tasks requiring local selection, spatial attention is less focused in urbanised than in remote peoples. While this has been widely proposed or inferred (e.g., Caparos et al., 2012; De Fockert, Caparos, Linnell, & Davidoff, 2011), it has never been tested. Experiment 1 used a local-selection task that involved selecting centrally presented target information and ignoring peripherally presented contextual information. It showed that remote peoples were better able to adapt to task requirements and displayed spatially focused attention whereas urbanised peoples were worse and displayed spatially defocused attention.

Experiment 2 went on to test another prediction that must follow from the cognitive-load and attentional-engagement accounts that both assume a critical role for cognitive resources. It is known that occupying cognitive resources on a secondary cognitive-load task while a task of local selection is performed defocuses spatial attention (Caparos & Linnell, 2010; Linnell & Caparos, 2011; De Fockert & Wu, 2009). Thus, according to both the cognitive-load and attentional engagement accounts, increasing cognitive load should make remote people appear like urbanised peoples. Indeed, in Experiment 2 we found that, under conditions of high cognitive load, the spatial attention of remote peoples was defocused and indistinguishable from the attention of urbanised peoples, suggesting a role for cognitive factors in the effect of urbanisation.
Experiments 3, 4 and 5 went on to test whether the effect of urbanisation is driven by the availability of working-memory or cognitive resources or by the engagement of these resources with the task in hand. If the urban environment acts as a cognitive load and depletes working-memory or cognitive resources, then performance on a working-memory task should be worse in urbanised peoples than in remote peoples. On the contrary, however, Experiment 3 showed that performance in a working-memory task was better in urbanised peoples, compatible with cognitive resources being more available but less engaged. In Experiments 4 and 5, it was argued that increasing attentional engagement in urbanised peoples while they were performing a task of local selection should focus their spatial attention and make them present like remote peoples; this is exactly what was found by manipulating the level of interest of the stimulus/task (Suzuki et al., 2004).

To measure the spatial focus of attention in all four experiments, we used a flanker paradigm with a separation manipulation similar to that used by Linnell and Caparos (2011). The separation-flanker paradigm is ideally suited to measuring the spatial focus of attention (Caparos & Linnell, 2009, 2010; Eriksen & St. James, 1986; Müller, Mollenhauer, Rösler, & Kleinschmidt, 2005). Flanker paradigms generally measure how much the time taken to identify a target stimulus in an attended location is affected by contextual distractors which flank the target; the greater the distractor interference on target identification, the more attention must have been deployed to distractors. In addition, the separation version of the flanker paradigm measures distractor interference at different separations from the target stimulus, making it possible to map out the spatial profile of attention and its focus around the attended target location. Based on earlier work (e.g., Bahcall & Kowler, 1999; Cave & Zimmerman, 1997; Cutzu & Tsotsos, 2003; Mounts, 2000; Müller et al., 2005), we know that the spatial attentional profile is shaped like a Mexican hat (or difference of Gaussians): with increasing separation from the attended location, attention decreases only to increase (before finally tailing off). The focus of the attentional profile can then be quantified as the separation from the attended location at which the bottom or first turning point of the Mexican-hat function occurs (Caparos & Linnell, 2009, 2010; Linnell & Caparos, 2011; see Figure 1). Within the finite window of separations sampled, a defocused Mexican-hat profile may present only its first decreasing arm and be mistaken for an ever decreasing gradient profile (Caparos & Linnell, 2009; see Figure 1); in such instances, the focus of the attentional profile can be quantified as the largest separation sampled. Qualitatively speaking, we should expect a Mexican-hat profile if spatial attention is focused but a gradient-like profile when it is defocused.
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**Figure 1.** Illustration of focused and defocused Mexican-hat attentional profiles. Given a limited sampling window, a defocused Mexican-hat profile may present as a gradient or steadily decreasing profile.

**Experiment 1**

Experiment 1 tested whether urbanisation impairs performance on a task of local selection by defocusing spatial attention. Traditional and urbanised Himba performed a flanker paradigm with a separation manipulation modelled on that in Linnell and Caparos (2011; Experiment 2): targets and distracters were left or right pointing arrows and the task was to ignore distractor arrows occurring at varying peripheral locations and focus on identifying the direction of the central target arrow (see Figure 2a).

To investigate the effects of upbringing as well as urbanisation, we compared traditional and urbanised Himba in two different age groups: (1) young adults, who had either spent all their lives in traditional villages (traditional group) or who had moved to a small town (Opuwo) permanently in early adulthood (urbanised group); (2) young adolescents, who had spent all their lives either in traditional villages (traditional group) or in Opuwo (urbanised group). Note that the second comparison focuses on adolescents rather than adults because Opuwo has only really developed since Namibian independence in 1990, so that there are limited numbers of adult Himba raised in Opuwo.

**Method**
**Participants**

The groups tested were: (1) 35 adult traditional Himba (16 females, mean estimated age 25 years, range 16-40), (2) 38 adolescent traditional Himba (26 females, mean estimated age 12 years, range 11-13), (3) 56 adult urbanised Himba (23 females, mean estimated age 27 years, range 17-40) and, (4) 37 adolescent urbanised Himba (17 females, mean estimated age 12 years, range 11-13). All traditional Himba tested were monolinguals (in Otjiherero) and had had little contact with the Western world; on average, they had been to Opuwo (the only town in the region) only 2.8 times (SEM=0.30) in their lifetime. The adult urbanised Himba tested in this experiment had grown up in a traditional Himba village and had traditional Himba parents; they had moved to Opuwo on a permanent basis later in life (at an average age of 21 years, SEM=1.04, range 6-34; they had been living in Opuwo for an average of six years (SEM=0.90) at the time of testing) and had generally never been to school. The adolescent urbanised Himba tested in this experiment had Himba parents and had grown up in Opuwo; they generally attended school regularly. None of the Himba had ever been involved in experimental research before. Participants were paid or rewarded in kind.

**Stimuli**

The stimuli were presented in black on a white background. Each stimulus display contained one left- or right-pointing target arrow subtending 1.4° (degrees of visual angle) horizontally and 1.75° vertically and four dot placeholders of diameter 0.4° (see Figure 2a). The target arrow and placeholders occupied five positions, arranged vertically and equally spaced along the vertical midline; the target only ever appeared at one of the three central positions (i.e., at fixation or just above or below fixation). The centre-to-centre separation between two adjacent placeholders, or between a placeholder and the target, was 2.4°. Each display also contained two left- or two right-pointing distractor arrows, presented to the left and right of the target, on the horizontal midline of the screen at a distance of 3.6°, 5.6°, 7.6°, 9.6° or 11.6° from fixation. They subtended 1.6° horizontally and 1.95° vertically. On half the trials, the direction of the distractor arrows was the same as that of the target (compatible trials), whereas on the other half of the trials, the direction of the distractor arrows was opposite to that of the target (incompatible trials).
Figure 2. Example stimulus displays all comprising a central target flanked by two peripheral distractors. All four examples illustrate response-incompatible displays with just one of the five possible target-distractor separations. The task was to indicate the direction in which the target was pointing (Experiments 1, 2 and 5 – ‘rightwards’ in 2a and 2b) or the colour/contrast polarity of the target (Experiment 4 – ‘white’ in 2c and 2d).

Procedure

Each trial started with a central fixation cross, shown for 1000ms, followed by the stimulus display for 220ms and then, again, by the fixation cross until a response was recorded. Participants were instructed to make a speeded key press to indicate the orientation of the target arrow, by pressing the left button on a two-button response box with their left hand for left target arrows, and the right button with their right hand for right target arrows. Participants were also told to ignore any other objects appearing on the screen. Participants first completed a practice session. As soon as they managed ten consecutive flanker trials with no more than one error, the experiment started; it consisted of 480 trials with a participant-terminated break every 120 trials.

Testing with traditional Himba took place in traditional villages, inside a large testing tent placed in a shaded area. Testing with urbanised Himba took place in Opuwo, inside a quiet and moderately lit testing room or, for a subset of adult urbanised Himba, inside the testing tent used with traditional Himba. Comparing urbanised Himba tested in the room and in the tent allowed us to test for possible effects of ambient lighting conditions. Instructions were
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given with the help of an interpreter who was naive to the purpose of the study. The experiment was run using E-Prime software (Schneider, Eschman, & Zuccolotto, 2002). Stimuli were presented on a 20-in CRT monitor (SONY Trinitron F520) at a viewing distance of 70 cm.

Results

In each group of participants, mean target-discrimination ('left' or 'right') RTs and error percentages were calculated for the five levels of target-distractor separation (3.6°, 5.6°, 7.6°, 9.6° and 11.6°) for incompatible- and compatible-distractor trials (see Figures 3 and 4). RTs were examined only for accurate responses, and only when they were longer than 200 ms and fell within two standard deviations of the overall mean for the participant (which represented an average of 92% of the latencies overall).

Distractor interference (in both RTs and errors) was then calculated for each participant by subtracting compatible-distractor mean RT/error from incompatible-distractor mean RT/error at each distractor separation (see Figures 3 and 4).

Figure 3. Flanker-task response-latency (RT) data in Experiment 1. Top: absolute latencies as a function of compatibility (incompatible distractors = plain lines; compatible distractors = dashed lines), target-distractor separation (3.6 to 11.6 deg), urbanisation (traditional...
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Himba, TH = black; urbanised Himba, UH = mid grey, and age (adult = left; adolescent = right). Bottom: distractor interference (incompatible- minus compatible-distractor RTs) as a function of target-distractor separation, urbanisation, and age. Error bars show +/- 0.5 SEM.

First we tested (1) the assumption that distractor interference as a function of separation followed a Mexican-hat pattern (see Müller et al., 2005; Caparos & Linnell, 2009, 2010; Linnell & Caparos, 2011) and (2) whether the pattern of interference varied across traditional and urbanised Himba and across age groups. A five (Separation) by two (Urbanisation) by two (Age Group) mixed-design ANOVA was used. The data from the urbanised Himba tested in a tent (see Method section) were not included in the analyses that follow; they were used in secondary analyses reported subsequently to dismiss effects of ambient lighting.

In the RT data, no main effect or interaction was significant (all p values > 0.05) other than the main effect of Separation ($F(4,568) = 15.3$, $p < 0.001$, $\eta^2_p = 0.097$) and the interaction between Separation and Culture ($F(4,568) = 5.7$, $p < 0.001$, $\eta^2_p = 0.039$). This result showed that interference varied as a function of separation and that the interference function of separation was different across traditional and urbanised Himba. Given the importance of the interaction, the effect of Separation was tested separately in traditional and urbanised Himba, using one-way repeated-measures ANOVAs, in order to establish the shape of the interference function in each group. In traditional Himba, there was a significant effect of Separation ($F(4,284) = 5.3$, $p < 0.001$, $\eta^2_p = 0.070$) and this effect was explained by a combination of quadratic and cubic trends (respectively, $F(1,71) = 8.9$, $p = 0.004$, $\eta^2_p = 0.111$, and $F(1,71) = 5.6$, $p = 0.021$, $\eta^2_p = 0.073$; the linear trend was not significant, $p > 0.05$). In urbanised Himba, on the other hand, while there was also a significant effect of Separation ($F(4,284) = 17.1$, $p < 0.001$, $\eta^2_p = 0.193$), this effect was explained by a combination of linear and quadratic trends (respectively, $F(1,71) = 53.5$, $p < 0.001$, $\eta^2_p = 0.430$, and $F(1,71) = 4.9$, $p = 0.031$, $\eta^2_p = 0.064$; the cubic trend was not significant, $p > 0.05$).

Thus, while the interference function of separation described a Mexican-hat pattern in traditional Himba, it described a gradient pattern in urbanised Himba. It is unlikely that these qualitatively different results reflect qualitatively different profiles of attention across groups. Instead, a more parsimonious interpretation of the data is that spatial attention was focused in traditional Himba, allowing us to index a full Mexican-hat profile, whereas it was less focused in urbanised Himba, allowing us to index only the first decreasing arm of the Mexican-hat profile (see Figure 1; see also Caparos & Linnell, 2009, 2010; Linnell & Caparos, 2011).

The Mexican-hat profile interpretation was tested directly by fitting the interference function of each participant using polynomial interpolations (Caparos & Linnell, 2009). These interpolations allowed us to derive the separation at which the bottom or turning point of the interference function occurred in each participant and to test whether the average separation differed across traditional and urbanised Himba. A third-degree polynomial model was used to fit the interference functions. This is the most conservative model that can be used to fit functions that can describe anything between a gradient and a Mexican-hat pattern. The separation of the bottom or first turning point of each interference function was calculated by taking the derivative of the third-degree polynomial fit. When the bottom or turning point of the function occurred outside the boundaries of the sampled separations, or when there was no bottom or turning point (i.e., when the function approached a straight line), the bottom was defined as the separation corresponding to the lowest point of the function within the
sampled interval (3.6° or 11.6°). Finally, bottom separation values were compared across traditional and urbanised Himba, and across adults and adolescents, using a two (Urbanisation) by two (Age Group) independent-design ANOVA.

Figure 4. Flanker-task error data in Experiment 1. Top: absolute error percentages as a function of compatibility (incompatible distractors = plain lines; compatible distractors = dashed lines), target-distractor separation (3.6 to 11.6 deg), urbanisation (traditional Himba, \( TH = \) black; urbanised Himba, \( UH = \) mid grey), and age (adult = left; adolescent = right). Bottom: distractor interference (incompatible- minus compatible-distractor error percentages) as a function of target-distractor separation, urbanisation, and age. Error bars show +/- 0.5 SEM.

The main effect of Urbanisation was significant \( (F(1,142) = 11.0, p = 0.001, \eta^2_p = 0.008) \): the bottom of the attentional profile occurred closer to fixation in traditional Himba (7.1°, SEM = 0.4) than in urbanised Himba (8.5°, SEM = 0.4; see Figure 3). In other words, attention was more focused in traditional than urbanised Himba. The main effect of Age Group was not significant \( (F < 1) \) and nor was the interaction between Urbanisation and Age Group \( (F < 1) \): the bottom occurred equally close to fixation in adult and adolescent traditional Himba (respectively, 7.0°, SEM = 0.4, and 7.3°, SEM = 0.4) and equally far from fixation in adult and adolescent urbanised Himba (8.5°, SEM = 0.4, in both groups).
To dismiss the possibility that the main effect of Urbanisation on focus was explained by differences in ambient lighting, the data of adult urbanised Himba tested inside the testing room (and used in the analyses above) were compared with data of adult urbanised Himba tested inside a tent (see Method section above) using a pairwise comparison. There was no effect of lighting on the bottom values of these two urbanised groups (the bottom of the profile occurred at 8.5° for both groups; $t(54) = 0.009, p = 0.993, d < 0.001$). For the sake of convenience, urbanised Himba were tested in the testing room in all subsequent experiments.

It is unlikely that the main effect of Urbanisation on focus can be explained by a difference in overall response latencies (i.e., by the fact that traditional Himba were slower than urbanised Himba; see Figure 3). The RT profiles of the two groups overlapped considerably and, indeed, a subset of traditional and urbanised Himba pair-matched on their overall latencies gave very similar outcomes. There was a significant main effect of Urbanisation ($F(1,70) = 4.6, p = 0.035, \eta_p^2 = 0.062$) such that the bottom of the profile was closer to fixation in traditional Himba (7.5°, SEM = 0.4) than urbanised Himba (8.7°, SEM = 0.4); the main effect of Age Group was not significant ($p > 0.1$) and neither was the interaction between Age Group and Urbanisation ($p > 0.1$).

To consider effects of practice on focus, we conducted post-hoc analyses on the traditional-Himba data. They showed no significant effect of practice in a comparison of the RT data from the first half of trials with the data from the second half (the bottom of the profile occurred at 7.7° in the first half of trials and 7.3° in the second half; $t(73) = 1.3, p = 0.197, d = 0.174$). Thus, task practice does not seem to provide an explanation for the differences in selectivity shown here.

Finally, the same analyses as those performed on interference calculated in RTs were performed on interference calculated in errors. The five (Separation) by two (Urbanisation) by two (Age Group) mixed-design ANOVA showed a significant main effect of Separation ($F(4,568) = 15.3, p < 0.001, \eta_p^2 = 0.0$) and of Urbanisation ($F(4,568) = 15.3, p < 0.001, \eta_p^2 = 0.0$); interference varied as a function of separation and was higher in urbanised than in traditional Himba (respectively, 0.5%, SEM=0.32, and 2.0%, SEM=0.368). However, neither the main effect of Age Group nor any of the interactions was significant (all $p$ values > 0.05), suggesting that the error data did not index any differences in spatial focus across groups. This was confirmed by analyses comparing the separations of the bottoms of the interference functions in errors which showed no significant main effect or interaction (all $p$ values > 0.05; see Figure 4).

In sum, Experiment 1 used analyses of interference functions in separation to confirm that the profile of attention describes a Mexican-hat pattern (Müller et al., 2005; Caparos & Linnell, 2009) and analyses of derivatives of interference functions to show that the profile was more focused in traditional than in urbanised Himba. Given that analyses of interference can only establish the shape of the profile of attention and not its focus, and that the central aim of this study is to examine differences in focus, in the experiments that follow analyses are confined to the bottom or turning point of each participant’s interference function and to comparing the separations at which the bottom occurred across groups.
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**Figure 5.** Illustration of the curve fitting procedure used to quantify spatial attentional focus. Interference was plotted as a function of separation. A cubic model was applied to the data and the attentional focus quantified as the separation of the bottom or first turning point of the resulting function. In the example illustrated on the right of this figure, where there was no bottom or turning point, the attentional focus would be estimated as the highest separation sampled (12 deg).

**Discussion**

As predicted by the cognitive-load and attentional-engagement accounts of urbanisation, the traditional Himba showed more focused spatial attention than urbanised Himba. As a result, the traditional Himba displayed a Mexican-hat profile of distractor interference, and urbanised Himba displayed a steadily decreasing or ‘gradient-like’ profile of interference (the first arm of a less focused Mexican-hat profile; see bottom of Figure 3). So, for the first time, the effects of urbanisation on the attentional focus have been directly shown rather than inferred.

One might have predicted that the effect of urbanisation would have been different in the adult group, either larger because it is confounded with relocation/dislocation or smaller because the adult group do not undergo the possible developmental effects of urbanisation. However, the effect of urbanisation on attentional focus was no different for adolescents (7.3° for traditional Himba compared to 8.5° for urbanised Himba) than for adults (7.0° for traditional Himba compared to 8.5° for urbanised Himba). Relocating to a small town in early adulthood and residing there for an average of 6 years exerted the same effect as being born there and residing there for an average of 12 years. Thus, we can rule out that relocation rather than, or in addition to, urbanisation drives the change in spatial focus. Also, the adult comparison does not appear to underestimate the effects of urbanisation by excluding effects of upbringing; this makes the inclusion of the adolescent comparison unnecessary in the experiments that follow.

One obvious potential artefact concerns differential familiarity in urbanised and traditional groups. It is likely that less familiarity with the testing scenario and task requirements explained some of the slowing in absolute RTs in traditional compared to urbanised Himba, but a subset of traditional and urbanised Himba pair-matched on their overall latencies gave
very similar outcomes. It is also likely that traditional Himba were less familiar than urbanised Himba with the arrow stimuli used here because these stimuli are more common in an urban environment. Lack of familiarity might be important in the present study if it increased the effective perceptual load of stimuli for the traditional Himba given that higher perceptual load focuses spatial attention (Caparos & Linnell, 2009; Lavie, 1995). However, the traditional Himba are more selective even when ignoring motion-singleton distractors (De Fockert et al., 2011) which are not susceptible to the effects of perceptual load (Jonides & Yantis, 1988; Yantis, 1993). Furthermore, lack of familiarity does not seem to be important in increasing selectivity in traditional Himba as there was no decrease in selectivity with very familiar (cow) stimuli (De Fockert et al., 2011). In any case, one might have predicted an opposite effect of familiarity as there is better selective attention with increasing practice (Kelley & Yantis, 2009) above. Indeed, the type of familiarity that we could call task expertise seems unlikely to explain our findings: experts perform similarly to (Boot, Kramer, Simons, Fabiani, & Gratton, 2008; Green & Bavelier, 2003), or even better than (Wilson, MacLeod, & Muroi, 2008), non-experts at attentional tasks.

We therefore conclude that in a task of local selection attention is spatially focused in remote peoples and spatially defocused in urbanised peoples, compatible with urbanisation impairing cognitive control.

Experiment 2

Experiment 2 tested a key prediction that we can make from the cognitive-load and attentional-engagement accounts of urbanisation, namely, that depleting cognitive resources in remote peoples should defocus their spatial attention in a task of local selection and make them present like urbanised peoples.

We sought to deplete cognitive resources by repeating Experiment 1 but adding a classic manipulation of cognitive load, namely working-memory (WM) load (Lavie, Hirst, De Fockert & Viding, 2004), for both traditional and urbanised Himba. Manipulations of WM load traditionally compare a low WM load with a high WM load that stretches memory almost to its limit; on this occasion, we chose to compare a high-load with a no-load condition (Lavie et al., 2004) given that we wanted to try to replicate the no-load findings from Experiment 1. Thus, while the no-load condition should replicate Experiment 1 in showing that traditional Himba are spatially focused and urbanised Himba defocused, the high-load condition should make both groups defocused if the cognitive-load and attentional-engagement accounts are correct.

Numbers in the Himba language (Otjiherero) are decimal based and words for digits between 1 and 9 are available to manipulate WM load in the traditional way by presenting digits acoustically and requiring their subsequent recall. A pilot experiment established that traditional Himba could reliably retain a maximum of three digits, in contrast to the Western span of six or more. Note however that Otjiherero words for digits 1 to 9 contain up to four syllables whereas the equivalent English words contain only up to two. Both the phonological complexity and the spoken duration of the average digit was therefore higher for the Himba, potentially providing at least a partial explanation for why the Himba could retain fewer digits (cf., English with Welsh; Ellis & Hennelly, 1980).

Method
Participants

The groups tested were: (1) 75 urbanised Himba (47 females, mean estimated age 27 years, range 17-46) and (2) 76 traditional Himba (32 females, mean estimated age 27 years, range 16-45). All traditional Himba tested were monolinguals (in Otjiherero) and had had little contact with the Western world (on average, they had been to Opuwo only 2.6 times, SEM= 0.23, in their lifetime). The urbanised Himba tested in this experiment had grown up in a traditional Himba village and had traditional Himba parents. They had moved to Opuwo on a permanent basis later in life (at an average age of 20 years, SEM=0.96, range 4-39; they had been living in Opuwo for an average of 6 years, SEM= 0.67, at the time of testing). None of the Himba had ever been involved in experimental research. Participants were paid or rewarded in kind.

Stimuli and procedure

Participants performed the same flanker task as in Experiment 1 except with 600 (instead of 480) trials. Four groups were compared: (1) traditional Himba in a condition of high cognitive load, (2) traditional Himba with no additional load (i.e., as in Experiment 1), (3) urbanised Himba in a condition of high cognitive load, and (4) urbanised Himba with no additional load (i.e., as in Experiment 1). The high-load condition was the same as the no-load condition except that a memory task was intercalated between blocks of trials. Three memory targets (i.e., three numbers randomly selected from between 1 and 9) were spoken in Otjiherero by the computer and followed by a 2,000-ms blank. The participants then performed a block of 8, 10 or 12 flanker trials; the three block sizes occurred equally often and in an unpredictable order. After the block of flanker trials, the three memorised numbers had to be reported orally. Sequence knowledge was not required. No feedback was given.

Results

Performance was first analysed for the memory task in the high-cognitive-load condition. On average, on each block of trials, traditional Himba correctly recalled 2.46 (out of 3) memory targets and urbanised Himba correctly recalled 2.64 (out of 3) memory targets; this difference was significant; t(71) = 2.9, p = 0.005, d = 0.686.

RTs and errors were then analysed in the flanker task. For each participant, mean target-discrimination (‘left’ or ‘right’) RTs and error percentages were calculated for the five levels of target-distractor separation (3.6°, 5.6°, 7.6°, 9.6° and 11.6°) for incompatible- and compatible-distractor trials (see Figures 6 and 7). In the high-load condition, the first two trials of each block were not analysed because traditional Himba frequently omitted to give a response to these trials as they were still focused on encoding the three memory targets. RTs were examined only for accurate responses, and only when they were longer than 200 ms and fell within two standard deviations of the overall mean for the participant; retained RTs represented an average of 90% of the analysable latencies.

Distractor interference (in both RTs and errors) was then calculated for each participant by subtracting compatible-distractor mean RT/error from incompatible-distractor mean RT/error at each distractor separation (see Figures 6 and 7).
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Figure 6. Flanker-task response-latency (RT) data in Experiment 2. Top: absolute latencies as a function of compatibility (incompatible distractors = plain lines; compatible distractors = dashed lines), target-distractor separation (3.6 to 11.6 deg), working memory or cognitive load (no or low c.load = left; high c.load = right) and urbanisation (traditional Himba, TH = black; urbanised Himba, UH = mid grey). Bottom: distractor interference (incompatible-minus compatible-distractor RTs) as a function of target-distractor separation, working memory load and urbanisation. Error bars show +/- 0.5 SEM.

In order to test for effects of urbanisation and cognitive load on the spatial focus of attention, distractor interference (in both RTs and errors) was mapped as a function of separation in each participant. Polynomial interpolations were used, as in Experiment 1, to isolate the separation at which the bottom or first turning point of the interference function occurred in each participant. Separation values were then compared across traditional and urbanised Himba, in both no- and high-cognitive-load conditions, using a two (Urbanisation) by two (Cognitive Load) independent-design ANOVA.

In the RT data, neither the main effect of Urbanisation nor that of Cognitive load was significant (respectively, $F < 1$, and $F(1,147) = 2.7$, $p = 0.098$, $\eta_p^2 = 0.019$). However, the interaction between Urbanisation and Cognitive load was significant ($F(1,147) = 4.5$, $p = 0.035$, $\eta_p^2 = 0.030$; see Figure 6), resulting from the bottom of the interference function occurring significantly closer to fixation in traditional Himba ($7.2^\circ$, SEM = 0.3) than in urbanised Himba ($8.4^\circ$, SEM = 0.4; $t(76) = 2.4$, $p = 0.036$, $d = 0.533$) in the no-cognitive-load
condition whereas, in the high-cognitive-load condition, there was no significant difference between traditional Himba (8.7°, SEM = 0.4) and urbanised Himba (8.2°, SEM = 0.4; t(71) = 0.8, p = 0.443, d = 0.208). In other words, while attention was more focused in traditional than urbanised Himba in the no-cognitive-load condition, replicating the findings of Experiment 1, attention was equally defocused in traditional and urbanised Himba in the high-cognitive-load condition.

In the error data, there were no significant main effects and no interaction (all p values > 0.1).

**Figure 7.** Flanker-task error data in Experiment 2. Top: absolute error percentages as a function of compatibility (incompatible distractors = plain lines; compatible distractors = dashed lines), target-distractor separation (3.6 to 11.6 deg), working memory or cognitive load (no or low c.load = left; high c.load = right) and urbanisation (traditional Himba, TH = black; urbanised Himba, UH = mid grey). Bottom: distractor interference (incompatible-minus compatible-distractor error percentages) as a function of target-distractor separation, working memory load and urbanisation. Error bars show +/- 0.5 SEM.

**Discussion**

Experiment 2 replicated the findings from Experiment 1 that the traditional Himba have a focused profile of spatial attention and the urbanised Himba a defocused profile while performing a local-selection task under conditions of no cognitive load. However, it also
showed that spatial attention in the traditional Himba was defocused by the introduction of a cognitive load. Indeed, the effect of cognitive load was indistinguishable from the effect of urbanisation: attention was defocused to an equal degree in the urbanised Himba under no cognitive load (8.4°) and in the traditional Himba under high cognitive load (8.7°). Thus, the detrimental effects of the urban environment on spatial attentional focus can be recreated in traditional people living in natural environments with the imposition of a cognitive load. The pattern of results is compatible with both the cognitive-load and attentional-engagement accounts of urbanisation therefore subsequent studies attempted to distinguish between the accounts.

Experiment 3

Experiments 3 explicitly tested the cognitive-load account. If the urban environment acts as a cognitive load by depleting working-memory or cognitive resources (Berman et al., 2008), then performance on a working-memory task should be worse in urbanised peoples than in remote peoples. The working-memory task we used was designed to be as straightforward as possible and involved the recall of sequentially presented auditory stimuli.

Method

Participants

The groups tested were: (1) 20 adult traditional Himba (12 females, mean estimated age 27 years, range 17-45) and (2) 22 adult urbanised Himba (10 females, mean estimated age 27 years, range 17-40). All traditional Himba tested were monolinguals (in Otjiherero) and had had little contact with the Western world; on average, they had been to Opuwo (the only town in the region) only 4.8 times, SEM=0.89, in their lifetime. The adult urbanised Himba tested in this experiment had grown up in a traditional Himba village and had traditional Himba parents; they had moved to Opuwo on a permanent basis later in life (at an average age of 20 years, SEM=1.05, range 6-33; they had been living in Opuwo for an average of seven years, SEM=2.04, at the time of testing). None of the Himba had ever been involved in experimental research before. Participants were paid or rewarded in kind.

Stimuli

The stimuli consisted of sequences of digits presented auditorily in Otjiherero using the speakers in the testing laptop set at full volume. The digits one to nine were randomly selected to create sequences of two, three, four or five digits. The same digit was never repeated within one sequence. 1000 ms elapsed between the beginning of the presentation of one digit and the beginning of the presentation of the following digit.

Procedure

Participants were seated 70 cm away from the testing laptop. On each trial, participants were asked to listen carefully to a sequence of digits auditorily presented by the computer and to recall it out loud immediately after. Both the experimenter and the interpreter recorded the digits recalled by the participant using pen and paper and, after cross checking for consistency, the experimenter typed them in. A new sequence of digits was then presented. Across the experiment, three sequences of two digits were followed by three sequences of
three, three sequences of four and, finally, three sequences of five digits. Before each sequence, participants were told how many digits they would have to listen to and recall.

**Results**

For each participant, recall accuracy was calculated for each of the 12 sequences. A sequence was counted as correctly recalled when all the digits in the sequence were recalled, no matter in which order. Each participant’s performance was summarised by determining the longest sequence of digits they recalled correctly on at least two out of three occasions.

A $t$-test analysis showed that urbanised Himba performed better on this measure (group mean $= 4.32$; SEM $= 0.14$) than traditional Himba (group mean $= 3.05$; SEM $= 0.15$; $t(40) = 6.2$, $p < 0.001$, $d = 1.86$).

**Discussion**

Experiment 3 showed that working-memory performance was higher in urbanised peoples, compatible with working-memory or cognitive resources being available but disengaged rather than, as in Berman’s view, unavailable.

**Experiment 4**

Experiment 4 more directly tested the attentional-engagement account of the effect of urbanisation. On that account, increasing the engagement of cognitive resources in a task of local selection in urbanised peoples should focus their spatial attention and make them present like remote peoples. In a bid to increase attentional engagement, the left- and right-pointing arrows used in Experiments 1 and 2 were replaced with black and white faces. Instead of participants discriminating the direction of the central target stimulus, they were asked to discriminate its colour or contrast polarity (black or white; see Figure 2c). Faces are highly salient stimuli, capturing and engaging attention to a singular extent (Theeuwes & Van der Stigchel, 2006). If the urbanised groups possess unengaged cognitive resources, then faces might be capable of engaging these resources and focusing spatial attention to the same extent as in remote peoples. By way of a stimulus control, we also introduced an inverted-faces condition that used identical stimuli but inverted them (see Figure 2d). Inverting faces radically interferes with their processing as faces (Yin, 1969) and most importantly decreases their engagingness (as indexed by activation of the amygdale; Sato, Kochiyama, Yoshikawa, 2011). Our prediction was therefore that urbanised peoples might be as spatially defocused as in earlier experiments with inverted faces.

Experiment 4 compared traditional Himba with urbanised Himba and now also with urbanised British. Himba who had relocated to Opuwo showed no less sensitivity to the Ebbinghaus illusion than an urbanised British sample living in London (Caparos et al., 2012). The point of including an urbanised British group was to see how closely the attentional profile of the urbanised Himba matched the profile of those from a far more urbanised environment than Opuwo.

**Method**

**Participants**
The groups tested were: (1) 71 traditional Himba (40 females, mean estimated age 22 years, range 16-45), (2) 57 urbanised Himba (31 females, mean estimated age 25 years, range 16-50) and (3) 53 urbanised British living in London (37 females, mean age 23, range 18-47). All traditional Himba tested were monolinguals (in Otjiherero) and had had little contact with the Western world (on average, they had been to Opuwo only 2.1 times, SEM=0.20, in their lifetime). The urbanised Himba tested in this experiment had grown up in a traditional Himba village and had traditional Himba parents. They had moved to Opuwo on a permanent basis later in life (at an average age of 18 years, SEM=1.18, range 8-35; they had been living in Opuwo for an average of 8 years, SEM=1.19, at the time of testing). None of the Himba had ever been involved in experimental research. Participants were paid or rewarded in kind.

Stimuli and procedure

The flanker task used in this experiment was performed on stimuli similar to those used in Experiments 1 and 2 except for the following differences. First, placeholders were removed and the target could no longer occur at fixation (i.e., it always occurred at the locations immediately above or below the fixation cross). Second, the target and distractors were white or black faces presented on a dark-grey background (see Figure 2c and 2d). Finally, the target and distractor faces could be presented upright or inverted (see Figure 2c and 2d).

The task consisted in indicating whether the target face was ‘white’ (with a left button press on the response box) or ‘black’ (with a right button press) while ignoring two distractors. The distractors could be compatible (e.g., black if the target was black), incompatible (e.g., white if the target was black) or there could be no distractor (no-distractor condition). The experiment consisted of 600 trials with participant-terminated breaks every 120 trials. Compatible-, incompatible- and no-distractor conditions were intermixed and occurred equally often. The upright-face and inverted-face conditions were performed by different participants.

Results

For each participant, mean target-discrimination (‘black’ vs. ‘white’) RTs and error percentages were calculated for the five levels of target-distractor separation (3.6°, 5.6°, 7.6°, 9.6° and 11.6°) for incompatible-, compatible- and no-distractor trials (see Figures 8 and 9). RTs were examined only for accurate responses, and only when they were longer than 200ms and fell within two standard deviations of the overall mean for the participant which represented an average of 95% of the latencies overall.

Distractor interference (in both RTs and errors) was then calculated for each participant by subtracting compatible-distractor mean RT/error from incompatible-distractor mean RT/error at each distractor separation (see Figures 8 and 9). In order to examine the spatial focus of attention, distractor interference (in both RTs and errors) was mapped as a function of separation in each participant. Polynomial interpolations were used, as in previous experiments, to isolate the separation at which the bottom of the interference function occurred in each participant. These separation values were compared across traditional Himba, urbanised Himba and urbanised British, in both upright and inverted conditions, using a three by two independent-design ANOVA, to test for effects of Urbanisation and Face Orientation.
In the RT data, the main effect of Urbanisation was significant ($F(2,175) = 7.0, p = 0.001, \eta^2_p = 0.074$); the bottom of the interference function occurred closer to fixation in traditional Himba (7.1°, SEM = 0.3) than in urbanised Himba (8.3°, SEM = 0.3; $p = 0.014$; $p$ values for multiple comparisons are Bonferroni corrected) but at similar separations in urbanised Himba (8.3°, SEM = 0.3) and British (8.5°, SEM = 0.3; $p > 0.1$). In other words, urbanised Himba and British participants were defocused while the traditional Himba were focused.

The main effect of Face Orientation was also significant ($F(1,175) = 4.0, p = 0.047, \eta^2_p = 0.022$); the bottom of the interference function occurred closer to fixation with upright faces (7.6°, SEM = 0.2) than with inverted faces (8.3°, SEM = 0.3). Thus, attention was more focused in the upright-face condition.

**Figure 8.** Flanker-task response-latency (RT) data in Experiment 4. Top: absolute latencies as a function of compatibility (incompatible distractors = plain lines; compatible distractors = dashed lines; no distractors = dotted lines), target-distractor separation (3.6 to 11.6 deg), urbanisation (traditional Himba, TH = black; urbanised Himba, UH = mid grey; urbanised British, B = light grey), and attentional engagement (low a.engagement/upside-down faces = left; high a.engagement/upright faces = right). Bottom: distractor interference (incompatible-minus compatible-distractor RTs) as a function of target-distractor separation, urbanisation, and attentional engagement. Error bars show +/- 0.5 SEM.
Finally, the interaction between Urbanisation and Face Orientation was significant ($F(2,175) = 3.2, p = 0.045, \eta^2_p = 0.035$; see Figure 8). Analysis of the interaction showed that, while there was a significant effect of urbanisation in the inverted condition ($F(2,85) = 10.0, p < 0.001, \eta^2_p = 0.191$), there was no such effect in the upright condition ($F < 1$). In the inverted condition, the bottom of the interference function occurred closer to fixation in traditional Himba (6.9°, SEM = 0.4) than in urbanised Himba (8.8°, SEM = 0.4; $p = 0.002$) and at similar separations in urbanised Himba (8.8°, SEM = 0.4) and British (9.1°, SEM = 0.4; $p > 0.1$). In the upright condition, the bottom of the interference function occurred at similar separations in all three groups (traditional Himba, 7.3°, SEM = 0.3; urbanised Himba, 7.7°, SEM = 0.4; British, 7.8°, SEM = 0.5; $p$ values > 0.1 for all comparisons). In other words, traditional Himba were more focused than urbanised Himba and British in the inverted condition but, in the upright condition, all three groups were equally (highly) focused.

In the error data, there were no significant effects (all $p$ values > 0.1).

![Flanker-task error data in Experiment 4. Top: absolute error percentages as a function of compatibility (incompatible distractors = plain lines; compatible distractors = dashed lines; no distractors = dotted lines), target-distractor separation (3.6 to 11.6 deg), urbanisation (traditional Himba, TH = black; urbanised Himba, UH = mid grey; urbanised British, B = light grey), and attentional engagement (low a.engagement/upside-down faces = left; high a.engagement/upright faces = right). Bottom: distractor interference (incompatible-]
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minus compatible-distractor RTs) as a function of target-distractor separation, urbanisation, and attentional engagement. Error bars show +/- 0.5 SEM.

Discussion

In the upright-face condition of Experiment 4, all groups were as spatially focused as the traditional Himba in previous experiments. Whereas inverting stimuli had no effect on traditional Himba, it defocused the urbanised Himba and British to an equal extent, reinstating the urbanisation effect seen in previous experiments and extending it to British participants. These findings provide support for the attentional-engagement account of urbanisation: urbanisation impacts selection by decreasing the engagement of cognitive resources, rather than by depleting them as suggested by Berman et al. (2008).

What was it about the upright-faces condition that managed to engage unspent resources in the urbanised groups? Was it just that upright faces are specially engaging, so that urbanised groups can only approach the selectivity of remote groups when upright faces, or perhaps also other ecologically salient stimuli, are involved? Alternatively, was it that the increased attentional engagement was due to the increased engagingness or interest of the task performed upon the stimuli? Asking participants to discriminate whether upright faces are ‘black’ or ‘white’ might have recruited race-discrimination mechanisms (Kubota, Banaji, & Phelps, 2012) - especially in multi-cultural London and post-apartheid Namibia - whereas asking participants to judge whether inverted faces are ‘black’ or ‘white’ might have relied less on such mechanisms and more on mechanisms involved in the discrimination of contrast polarity. To determine which possibility was more likely, Experiment 5 used upright-face stimuli but with a potentially less engaging task that was less likely to recruit race-discrimination mechanisms.

Experiment 5

Experiment 5 was a face-stimulus version of Experiment 1, where left-pointing arrows were replaced with heads turned to the left, and right-pointing arrows with heads turned to the right. Participants discriminated the direction of the central target head, just as in Experiment 1 they had discriminated the direction of the central target arrow (see Figure 2b). If it were upright heads that were special, the results of Experiment 5 should be identical to those from Experiment 4, and urbanised Himba and British participants should present spatially focused attentional profiles. If, however, it was the recruitment of race-discrimination mechanisms that explained results in the upright condition of Experiment 4, then discriminating the orientation of a turned head should recruit these mechanisms less and urbanised Himba and British participants should present defocused attentional profiles, as in Experiment 1.

Method

Participants

The three groups tested were: (1) 32 traditional Himba (15 females, mean estimated age 25 years, range 16-45), (2) 29 traditional Himba (12 females, mean estimated age 27 years, range 18-48) and (3) 29 urbanised British living in London (19 females, mean age 22, range 18-35). All traditional Himba tested were monolinguals (in Otjiherero) and had had little
contact with the Western world (on average, they had been to Opuwo only 1.8 times, SEM=0.24, in their lifetime). The urbanised Himba tested in this experiment had grown up in a traditional Himba village and had traditional Himba parents. They had moved to Opuwo on a permanent basis later in life (at an average age of 22 years, SEM=1.39, range 6-35; they had been living in Opuwo for an average of 5 years, SEM=0.91, at the time of testing). None of the Himba had ever been involved in experimental research. Participants were paid or rewarded in kind.

**Stimuli and procedure**

In this experiment, the participants performed the same flanker task as in Experiment 1, except that instead of left and right pointing arrows, left and right turned heads were used as target and distractors (see Figure 2b).

**Results**

For each participant, mean target-discrimination (‘left’ vs. ‘right’) RTs and error percentages were calculated for the five levels of target-distractor separation (3.6°, 5.6°, 7.6°, 9.6° and 11.6°) for incompatible- and compatible-distractor trials (see Figures 10 and 11). RTs were examined only for accurate responses, and only when they were longer than 200 ms and fell within two standard deviations of the overall mean for the participant; in total 6% of the latencies were excluded.

Distractor interference, in both RTs and errors, was then calculated for each participant by subtracting compatible-distractor mean RT/error from incompatible-distractor mean RT/error at each distractor separation (see Figures 10 and 11). In order to examine the spatial focus of attention, distractor interference (in both RTs and errors) was mapped as a function of separation in each participant and polynomial interpolations were again used to isolate the separation at which the bottom of the interference function occurred in each participant. These separation values were compared across traditional Himba, urbanised Himba and urbanised British using an independent one-way ANOVA to test for an effect of urbanisation.
In the RT data, the main effect of Urbanisation was significant ($F(2,87) = 3.8, p = 0.026, \eta^2_p = 0.080$); the bottom of the interference function occurred closer to fixation in traditional Himba (7.4°, SEM = 0.4) than in urbanised Himba (9.0°, SEM = 0.4; $p = 0.023$; $p$ values for multiple comparisons are Bonferroni corrected) but at similar separations in urbanised Himba (9.0°, SEM = 0.4) and British (8.6°, SEM = 0.5; $p > 0.1$). Post-hoc analyses showed that this effect of Urbanisation (i.e., comparison of traditional Himba, urbanised Himba and British) was similar to the one found in the inverted condition of Experiment 4 (the interaction between the factors Urbanisation and Experiment was not significant; $F(2,178) = 1.4, p = 0.254, \eta^2_p = 0.016$). Equally, the effect of Urbanisation was similar in Experiments 1 and 5 (when comparing adult traditional Himba with adult urbanised Himba, the interaction between the factors Urbanisation and Experiment was not significant; $F(1,128) = 0.2, p = 0.904, \eta^2_p < 0.001$).
Figure 11. Flanker-task error data in Experiment 5. Top: absolute error percentages as a function of compatibility (incompatible distractors = plain lines; compatible distractors = dashed lines), target-distractor separation (3.6 to 11.6 deg) and urbanisation (traditional Himba, TH = black; urbanised Himba, UH = mid grey; urbanised British, B = light grey). Bottom: distractor interference (incompatible- minus compatible-distractor error percentages) as a function of target-distractor separation and urbanisation. Error bars show +/- 0.5 SEM.

In the error data, the main effect of Urbanisation was also significant ($F(2,87) = 4.0$, $p = 0.022$, $\eta_p^2 = 0.087$); the bottom of the interference function occurred closer to fixation in traditional Himba (6.9°, SEM = 0.4) than in urbanised Himba (8.7°, SEM = 0.5; $p = 0.016$; $p$ values for multiple comparisons are Bonferroni corrected) but at similar separations in urbanised Himba (8.7°, SEM = 0.4) and British (8.0°, SEM = 0.5; $p > 0.1$).

In sum, in both RTs and errors, urbanised Himba and British participants were equally defocused compared to traditional Himba.

Discussion
We first make some further comments about the unimportance of familiarity in producing our results. The equivalence of the pattern of findings in Experiments 1 (with left and right turned arrows) and 5 (with left and right turned faces) is noteworthy in suggesting that familiarity with experimental stimuli is not the factor driving the differences in spatial attentional focus between urbanised and non-urbanised groups (see also De Fockert et al., 2011). Also relevant to the familiarity issue is the finding that attention was as defocused in urbanised Himba as in urbanised British participants (Experiment 4, inverted condition, and Experiment 5). Our stimulus/task was far less familiar to the urbanised Himba than to the British; the majority of urbanised Himba tested had never used a computer while the British participants were university Psychology students.

We also note that differences in perceptual load between tasks will not explain our data. The task of discriminating head-orientation depends on subtle shape processing and its perceptual load is inherently higher than that of contrast-polarity discrimination. So, task-induced differences from perceptual load would predict that the head-orientation task should produce more, rather than less, focused attentional profiles (Caparos & Linnell, 2009, 2010; Linnell & Caparos, 2011).

The critical outcome of Experiment 5 was that findings with the face-orientation task on upright faces were indistinguishable from those in Experiment 4 with the ‘black’/‘white’ task on inverted faces. We conclude that presenting upright faces (or other ecologically salient stimuli) is not in and of itself sufficient to focus attention in urbanised groups. Instead, we argue that focusing is only produced when the stimulus/task scenario is sufficiently engaging or interesting (see also Suzuki et al., 2004). Our findings suggest that urbanised groups do not routinely engage all their cognitive resources but can engage them when a stimulus/task is more engaging or interesting.

**General Discussion**

The current study used a separation-flanker paradigm to examine the effect of urbanisation on the ability to perform a task requiring local selection. It compared traditional Himba (a remote people) with urbanised Himba and urbanised British. It showed that attention was spatially focused in traditional Himba but defocused in urbanised Himba raised in a traditional fashion but relocated to town in early adulthood (Experiments 1, 2, 4 and 5); in addition, it showed that attention was as defocused in urbanised Himba who had moved to town (Opuwo) in early adulthood as in urbanised Himba born and raised in town (Opuwo; Experiment 1) and in British participants living in London (Experiments 4 and 5); see Figure 12). These differences in attentional focus are compatible with previous data: the traditional Himba showed little Ebbinghaus size-contrast illusion but the urbanised Himba showed the same substantial illusion as urbanised British (Caparos et al., 2012). Indeed, we conclude that the attentional differences we report here are the drivers for these considerable differences in the processing of contextual stimuli.

Most strikingly, the current study also showed that, while the spatial attention of the traditional Himba was focused under no cognitive load, it was as defocused as in urbanised Himba under high cognitive load (Experiment 2). A variation of focus with cognitive load is compatible with the account of urbanisation of Berman et al. (2008) but that account does not predict the better working-memory performance of the urbanised Himba (Experiment 3). An attentional-engagement account, however, can explain the greater focus of traditional Himba.
Urbanisation decreases engagement despite their worse working-memory performance, as well as our finding that increasing stimulus/task interest focused attention in urbanised Himba and British participants to the point where it became as focused as in traditional Himba (Experiments 4 and 5; see Figure 12 for an overview of findings).

**Figure 12.** Summary of the attentional-focus data from all four separation-flanker experiments (traditional Himba, TH; urbanised Himba, UH; British, B; cognitive load, CLoad).

Our results suggest that issues relating to attentional engagement may need to be considered more generally when conducting research into attention in urbanised populations. The efficiency of selection with upright faces (in Experiment 4) suggests that selection is underestimated by the types of stimuli/tasks often used in attention research (see, e.g., the arrow stimuli used in Experiments 1 and 2, and the inverted faces and turned heads used in Experiments 4 and 5 respectively). Attention research has emphasised that spatial selectivity in local-selection tasks is poor except where perceptually difficult, or high-perceptual-load, stimuli are involved that are assumed automatically to focus attention (Lavie, 1995; Lavie et al., 2004). However, we argue that perceptually difficult stimuli focus attention in these tasks through increasing the attentional engagement of cognitive resources (Linnell & Caparos, 2011); thus, perceptual load or task difficulty is just one of several factors including level of interest (Suzuki et al., 2004), urbanisation, and quite possibly also development through adolescence (Doherty, Campbell, Tsuji, & Phillips, 2010), that influence the degree of attentional engagement and thus the spatial focus of attention in tasks of local selection.
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We turn now to examine how the effects of urbanisation on attentional engagement might be related to effects on perceptual bias (Miyamoto et al., 2006; Caparos et al., 2012; Caparos et al., in press). While we argue here that decreased attentional engagement explains the increased contextual processing of urbanised peoples, it requires additional assumptions to explain the global perceptual bias of urbanised peoples (Miyamoto et al., 2006). A global perceptual bias could be driven by differences in the visual environment. For example, visual clutter (Miyamoto et al., 2006) or the constant presence of printed materials (Szwed, Ventura, Querido, Cohen, & Dehaene, 2012) could produce a bias away from local processing, but it is also possible that a global bias is related, at least in part, to the decrease in engagement caused by urbanisation. Indeed, decreased engagement - which supports exploration and the detection of potential dangers or new opportunities (McGilchrist, 2010; Singh-Curry & Husain, 2009) - might result in the default state of spatial attention expanding to encompass the whole visual field, thus encouraging long-range perceptual interactions and a global perceptual bias, particularly if it occurred during a critical period of development. Nevertheless, our findings suggest that there is no such critical period in development determining attentional engagement itself; the effects of urban living on attentional engagement were as substantial in traditional Himba who had moved to town in early adulthood, in urbanised Himba born and raised in town, and in British participants living in a city.

So, how might simply living in urban environments exert such dramatic effects on attentional engagement with the task in hand? We know that urban living impacts the amygdala (Lederbogen, Kirsch, Haddad, Streit, Tost, Schuch, Wüst, et al., 2011) which plays a central role in the alerting system (e.g., Davis & Whalen, 2001; Oken, Salinsky & Eisas, 2006; Posner & Petersen, 1990). Furthermore, Singh-Curry & Husain (2009) have suggested that variations in intrinsic or tonic alertness tip the balance between task engagement and exploration. We suggest that traditional people may have a level of tonic alertness that is optimal to support attentional engagement with the task in hand. In contrast, urbanised peoples - whose environments are possibly more stressful (Lederbogen et al., 2011) - may have slightly higher levels of tonic alertness (Broadbent, 1976) which engender less task engagement but are more conducive to exploration and adapting to changing environmental conditions. Even higher levels of tonic alertness may be found in East Asian than Western cultures. East Asians have a greater susceptibility to contextual illusions than Westerners (Caparos et al., 2012; Doherty, Tsuji & Phillips, 2008) and this might be explained by reduced attentional engagement rather than by differences in social structure as proposed by Nisbett and colleagues (e.g., Nisbett, Peng, Choi & Norenzayan, 2001; Varnum, Grossmann, Kitayama & Nisbett, 2010). Thus, differences in attentional engagement and selectivity may explain some cross-cultural differences in the processing of contextual information that are confounded with variations in urbanisation.

In sum, our examination of the effect of urbanisation on a remote people argue that urbanisation reduces attentional engagement and cognitive control, possibly through effects on the alerting system, and results in attention only to events of high engagingness. While reduced attentional engagement may be advantageous in high-demanding urban scenarios, it comes at the cost of a generally reduced level of selectivity. Parsimony would suggest that our account is applicable across the globe, even though few places exist today where differences in urbanisation are as large as in the remote part of Namibia that is home to the Himba.
Urbanisation decreases engagement

Acknowledgements

This work was supported by a grant from the ESRC (2558227) and a grant from the British Academy (2558241). We also thank Cambridge Research Systems for their hardware support, Charles Spence for providing the stimuli from which our face stimuli were derived, and Mel Goodale, Andy Bremner and Ilona Kovacs for helpful discussions.

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Article DOI:
10.1037/a0031139