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Attention mediates the effect of context-relevant social meaning on prospective duration judgments

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Abstract

In everyday life we perceive events as having durations. Recent research suggests that the labeling of a stimulus influences the experience of its duration. Plausibly, the social meaning attributed to a stimulus impacts upon the amount of attention allocated to it, with greater attention resulting in better encoding and longer reproduction times. However, direct evidence for the role of attention in this effect of social meaning on duration reproduction is lacking. The present study addresses this issue directly. Eighty four male Hindu pilgrims attending the *Kumbh Mela* in India listened to an ambiguous sound-clip and reproduced its duration in a prospective timing task. The context-relevant social meaning of this sound-clip was manipulated through attributing the sound to either the religious festival or busy city streets. Attentional load was manipulated by asking half the participants to perform a concurrent task. Reproduced durations were longer in the Mela compared to the City condition but only when participants completed a single task. The finding that mere labeling of the stimulus impacts duration judgments in a prospective paradigm in the single task but not the dual task conditions suggests that the effect of social meaning is indeed mediated through the deployment of attentional resources.

Key words: social meaning; time perception; duration judgment; attention; prospective paradigm; dual task

Introduction

In line with Bruner's (1957) 'new look' approach, researchers have investigated the role of social and motivational factors in perception (Balcetis & Dunning, 2006, Greenwald, 1992; Wegner & Bargh, 1998). Such research shows that social experience and thus the meaning attributed to stimuli can determine their recognition and categorization (Boyce & Pollatsek, 1992; Li & Warren, 2004; Toppino & Long, 2004). Typically, such investigations have focused on visual perception, and here, we extend this work to consider time perception.

Time is an essential aspect of our everyday experience. We perceive events as happening in time and as having durations. Such durations are key elements of the phenomenal experience of a stimulus, and investigating them allows insight into the psychological mechanisms involved in stimulus processing. Typically, when participants are asked to reproduce a sound's duration, they underestimate it (Eisler, 1976). The extent of such under-estimation is affected by many factors, e.g., the complexity of the stimulus (more complex sounds are judged to last longer than simple sounds: Buffardi, 1971), and the individual's familiarity with the stimulus (more familiar sounds are judged longer than unfamiliar sounds: Kowal, 1987). Similarly, duration estimates increase if the time period contains more meaningful events (Zakay & Block, 1997) or more information is processed (Brown, 1985; Fortin & Breton, 1995).

The mechanisms involved in such effects are diverse and depend upon the paradigm used. In retrospective paradigms (where participants do not know they will be asked to estimate the duration of a stimulus) memory processes seem particularly relevant: the more richly a stimulus is encoded the longer the stimulus is judged to have lasted. However, in prospective paradigms (where participants know they will be asked to make such estimates), duration estimates are particularly sensitive to factors impacting the degree to which attention is allocated to monitoring temporal information (Block & Zakay, 1997; Brown, 1985, 1997,

2008, 2010; Grondin, 2010; Phillips & Cross, 2011; Tobin, Bisson, & Grondin, 2010). This is well illustrated in studies that include manipulations, which reduce the attentional resources available to monitor temporal information. In such dual task studies (wherein resources are shared between the temporal task and a secondary non-temporal task) duration estimates are reduced (Brown, 1997, 2008; Block & Zakay, 1996; Grondin, 2010).

Thus far, researchers interested in time perception have manipulated the complexity and familiarity of the auditory material (Buffardi, 1971; Kowal, 1987) or varied the social characteristics of the perceiver (Eisler & Eisler, 1999). Yet if one wishes to investigate how social factors impact upon reproduced durations there is much to be gained in keeping such variables constant and manipulating instead the perceiver's understanding of the sound they hear (e.g., by varying its labeling of the origin or social context of the sound). Such a study would show how perceivers' understandings of the sound's social meaning impacted upon its processing. This is exactly the logic to a recent study by Srinivasan et al. (2013) which examined how reproduced durations of the same stimulus were affected by participants' understanding of the sound's origin (and thus its contents).

Srinivasan et al's research was conducted at a Hindu festival (or Mela) where hundreds of thousands (sometimes millions) of pilgrims camp together by the river Ganges for a month. For the pilgrims this is a deeply meaningful event. They do not leave the Mela site throughout the whole month and during this period they follow a disciplined routine that starts before dawn and is centered on a variety of religious activities. To fulfil one's duties as a pilgrim takes physical and mental effort. The Mela site comprises of tents, markets, roads, field hospitals and post offices. The site is far from tranquil or silent (Shankar et al., 2013). There is noise from traffic, from large numbers of people moving back and forth, and from hundreds of loudspeakers which broadcast religious songs, religious speeches, and also non-religious announcements. Moreover, the pilgrims are routinely exposed to multiple

simultaneous loudspeaker broadcasts such that it is often difficult to discern the contents of these broadcasts or differentiate between the various noises surrounding the pilgrims. The end result is a loud cacophony (85-90 dB) that resembles the noise of a busy city street.

Shankar et al. (2013) addressed the psychological importance of mela-relevant religious sounds by presenting pilgrims with a specially prepared ambiguous sound-clip that contained very little recognizable material. This ambiguity meant that the sound-clip could be labeled as comprising sounds recorded at either the religious festival itself (which implied it contained elements of sound that would have religious significance) or from the secular setting of busy city streets (where religious sounds would be absent). Participants were to listen to this sound-clip for as long as they wished. The results showed they listened longer when it was labeled as originating from the Mela rather than from busy city streets. They also rated the sound-clip attributed to the Mela as more interesting. In addition to these experimental data, Shankar et al report interview data which suggested that although frequently heard sounds from the Mela that had secular connotations (e.g., non-religious songs, traffic horns) were reported as unwanted, sounds that had religious connotations were welcomed as contributing to pilgrims' spiritual experience of the Mela.

Such findings suggest that the Mela is an ideal context in which to study the effects of social meaning on the experience of a sound. First, this context allows for the production of an ambiguous sound-clip that could be labeled differently (Mela vs city). Second, when labeled as Mela-related participants regarded the sound-clip more positively and listened to it for longer. Accordingly, in order to study how social meaning impacts on sound duration reproduction, Srinivasan et al. (2013) took advantage of this context and presented pilgrims with an ambiguous sound clip, which was again attributed to either the religious festival itself or to the secular setting of busy city streets. Indeed, Srinivasan et al used the same sound clip as was used by Shankar et al. (2013), except that it was now presented for a fixed duration of

20 seconds. After presentation of the stimulus, participants were asked to reproduce the sound-clip's duration and Srinivasan et al investigated how this was affected by its labeling. The researchers reasoned that labeling the sound as originating from the Mela would give it a particular (religious) meaning and significance that would be absent when the sound was labeled as originating in busy city streets. Moreover, they reasoned that as the physical properties of the stimulus and the characteristics of the participants (pilgrims at the event) were constant, between-condition differences in duration estimates would constitute evidence of the impact of the social meaning of the stimulus on its processing. This is exactly what was found: when the sound-clip was attributed to the Mela, participants produced longer (and more accurate) estimates than when it was attributed to city streets.

Although Srinivasan et al. (2013) show that the social meaning of a sound affects the psychological experience of its duration, the key question of the mechanisms behind this effect is unclear. Srinivasan et al. (2013) employed a retrospective paradigm in which participants were unaware that they would have to reproduce the sound-clip's duration until after the stimulus was presented. Previous research using such retrospective paradigms suggests memory processes determine duration judgments, with better encoding resulting in more accurate and longer estimates (Block, Hancock, & Zakay, 2010). Thus it is likely that the sound-clip's labeling affected its encoding. However, this does not mean that attentional mechanisms are irrelevant (Brown, 1985). Encoding is itself influenced by attentional processes (Hicks, Miller & Kinsbourne, 1976; Macar, Grondin, & Casini, 1994; Zakay & Block, 1996), and Srinivasan et al. (2013) reasoned that the longer duration estimates obtained in the Mela condition arose because the sound-clip received more attention due to its significance (as participants listened out for snippets of sound that had religious meaning), with the corollary that it was more elaborately encoded (and more accurately remembered) than in the city condition (where the sound-clip had no such religious elements. The present

study is the first to test directly this reasoning concerning the role of attentional mechanisms in this effect.

In order to investigate the role of attentional mechanisms we developed a design that had two distinctive features. First, whereas Srinivasan et al. (2013) employed a retrospective duration-perception paradigm, we used a prospective paradigm (that is, participants knew they would be asked to estimate the duration of the stimulus). Although both prospective and retrospective time-perception paradigms are likely to involve attentional mechanisms, research shows such mechanisms to be particularly important in prospective paradigms (Block & Zakay, 1997; Brown, 2010; Phillips & Cross, 2011; Tobin, Bisson, &Grondin, 2010). This means a prospective paradigm is particularly appropriate for investigating the role of attentional mechanisms in Srinivasan et al's effect of social meaning on duration reproduction: If we obtain the same effect reported by Srinivasan et al but in a paradigm known to be heavily influenced by attentional processes (i.e., a prospective paradigm) we would have further evidence for the role of attentional mechanisms in explaining why the social meaning attributed to a stimulus affects duration reproductions.

A second feature of the current design is that it included a manipulation designed to vary the amount of attentional resources participants had at their disposal and so allow further investigation the role of such resources in mediating the impact of social meaning on duration estimates. Previous studies show that performing a concurrent secondary task with a duration task results in shorter duration estimates because performing this secondary task further reduces the resources participants can allocate to the stimulus and temporal information (Brown, 1997; Brown & Merchant, 2007; Field & Groeger, 2004). Accordingly, we included such a manipulation to investigate if the effect of social meaning on duration perception would be attenuated when attentional load was high. If it was not (and the effect of the labeling of the sound's origin remained as strong as when participants had no extra

attentional load) this would imply that attention was not a key factor behind the labelling effect.

As with the earlier study (Srinivasan et al., 2013), the current research was conducted in the field setting of the same Hindu festival (Mela), but in a different year (the 2013 Kumbh Mela). Pilgrim participants heard the same ambiguous sound-clip used in Srinivasan et al. (2013) study, and this was attributed to either the Mela or busy city streets (this source attribution was always made before the sound-clip was played). Participants were told in advance that they would be asked to reproduce the sound-clip's duration. We hypothesized that even when participants knew they would have to reproduce the sound-clip's duration, it would be easier (due to its apparently religious importance or relevance) for the pilgrim participants to pay attention to the ambiguous noisy stimulus if it was imbued with spiritual goal-relevant social meaning through its association with the religious Mela than its association with the mundane and secular context of busy city streets. This in turn would result in easier processing and better encoding of the stimulus when the sound-clip was labeled as from the Mela rather than the city. Moreover, one could expect that this ease of processing would allow more resources for the processing of temporal information when the sound-clip was labeled as from the Mela rather than the city and that this would be manifested in longer duration estimates. However, we also expected that if the social meaning effect is mediated by attentional processes, then the effect would be reduced in the dual task conditions due to the availability of less attentional resources.

Method

Participants. Eighty four Hindu male pilgrims (*M* age = 65.99 years, *SD* = 6.81) provided verbal consent and participated in the experiment. The sample was drawn from pilgrims (or Kalpwasis) staying in the Mela for a month and the data were collected during their stay at

the Mela site. Participants were recruited randomly from the market streets near the experimental tent.

Stimuli. The ambiguous auditory stimulus was a noisy sound-clip that included elements recorded at the Mela, city streets, and also white noise that was added in order to make it impossible to identify specific sounds (Shankar et al., 2013, henceforth referred as *ambiguous sound clip*). The duration of the clip was 20 seconds and was the same stimulus used in an earlier study (see Srinivasan et al., 2013). The dual task was a pair cancellation task involving a sheet of paper that contained an array of figures made of dogs, balls, and cups (Lezak, Howieson, Bigler, & Tranel, 2012).

Procedure. The study was performed in a tent in the Mela. Experimenter 1 recruited the participants from the market street near the tent. A second experimenter (Experimenter 2) was located in the tent and conducted the experiment. Experimenter 1 was blind to the manipulation condition.

We employed a prospective paradigm in which participants were informed (by experimenter 2) that they would be asked to judge the duration of a sound-clip. This instruction was given prior to presentation of the auditory stimulus. Participants listened to the 20-second stimulus through headphones that blocked external noises. Immediately after listening to the sound-clip, participants reproduced its duration (while continuing to wear the headphones but without any sound played just to block or minimize the effect of any external environmental noise which could interfere with the reproduction task). Duration was measured using a stopwatch, the display of which was neither visible to experimenter 2 nor the participant. Experimenter 2 signaled 'start', and then, when the participant felt that the duration for which they originally listened to the clip had elapsed, the participant said 'stop'.

Experimenter 2 recorded this duration. To familiarize the task, each participant was given a practice with a 5 second long unrelated sound clip before the experimental trial.

We employed duration reproduction as this is more sensitive than alternative methods of duration estimates and is not biased by participants' use of numbers (see Brown, 1985; McKay, 1977). Participants were asked to take off their watches and there were no other objects in the tent, which could facilitate accurate duration estimation. As we used a relatively long duration, there was a possibility that participants could mentally count and use this as a cue for duration reproduction. Accordingly, we instructed participants not to count (and this has been shown to be successful in preventing counting: Rattat & Droit-Volet, 2012). Before listening to the experimental stimulus, participants received a practice trial with a 5 seconds long unrelated sound-clip (to familiarize them with the duration reproduction task).

Participants were randomly assigned to the Mela or City conditions based on what priming they received. Half were primed to believe these sounds came from everyday sites in a City, and half were primed to believe these (same) sounds came from the religious site of the Mela (which contains bathing areas or 'ghats' along the banks of the holy Ganges and a particularly auspicious area with strong spiritual connotation called the 'Sangam'). These primes were as follows and were delivered in Hindi:

City condition - *'we have jumbled together various sounds from the city – for example, from markets, from railway stations, from bus station, from various places in the city. OK? So now you are going to listen to the sounds of the city.'*

Mela condition - '*we have jumbled together various sounds from the Mela – for example, religious broadcasts over the loudspeaker system, from the Ghats on the*

Ganges, from the Sangam, from various places in the Kumbh Mela. OK? So, now you are going to listen to the sounds of the Mela.'

Participants were recruited to one of four conditions. Two were single task conditions involving only the prospective duration judgment task. In one of these the sound was attributed to the Mela, in the other, the city. The other two conditions were dual task conditions in which participants were asked to perform a concurrent visual task in addition to the prospective timing task. The concurrent task was a visual pair cancellation task in which participants were asked to mark as many pairs (dog followed by ball) as possible from an array of figures made of dogs, balls, and cups (Lezak, et al., 2012). Again, in one of these conditions the sound was attributed to the Mela and in the other it was attributed to the city. To check whether participants absorbed the information about the sound's source, all participants were asked to recall the source of the sound-clip at the end of the experiment.

Results

Two participants (one from the Mela-single task condition and another from the City-single task condition) were excluded because they erroneously recollected the sound's source (Cell sizes: Mela single task = 22; City single task = 21; Mela dual task = 21; City dual task = 20). We performed a 2 (social context: Mela, City) and x 2 (attentional load: single task, dual task) between-subject Analysis of Variance on the reproduced durations. The main effect of social context was significant, $F(1, 80) = 5.35$, $p = .023$, $d = .51$, with longer duration estimates in the Mela compared to the city condition. The main effect of attentional load was significant $F(1, 80) = 34.78$, $p < .0001$, $d = 1.3$, with shorter durations in the dual task compared to the single task condition. More importantly, the interaction between social context and attentional load was also significant, $F(1, 80) = 7.24$, $p = .009$, $d = 0.6$. Post-hoc

comparisons showed that when participants just listened to the sound-clip (single task), duration judgments were longer in the Mela condition ($M = 15.31$, $SE = 0.93$) than in the city condition (M=11.88, $SE = 0.72$), $t(41) = 5.00$, $p = 0.004$, $d = 0.88$. In contrast, when participants also performed a concurrent visual task, the difference between duration judgments in the Mela ($M = 9.42$, $SE = 0.43$) and city ($M = 9.68$, $SE = 0.47$) conditions was not significant, $t(39) = 0.38$, $p > 0.5$, $d = 0.13$.We also found that when the sound-clip was attributed to the Mela, the difference between the duration judgment in the single and dual task conditions was significant, $t(41) = 8.59$, $p < .0001$, $d = 1.73$.

Insert Figure 1 here

These results show that the effect of social meaning is present only in the single task condition (and not in the dual task condition). This implies that the amount of attentional resources available for processing social meaning influences duration judgments, and that when those resources were available, the longest durations were found when the sound-clip was labeled as originating in the Mela (and thus as containing noises recorded at religiously significant sites).

For information, the duration-ratio judgments (reproduced duration divided by actual stimulus duration) are as follows: Mela single task = .77; Mela dual task = .47; City single task .56; City dual task = .48. Again this conveys the point that reproduction durations are shorter than the actual duration but that this underestimation is less when the sound is labeled so as to give it a significant social meaning and participants have the attentional resources to devote to it. Performance on the concurrent task did not differ across the two conditions, $t(39) = .325$, $p = .75$, $d = 0.1$ with similar performance in the Mela (2.95 correct responses, $SD = 0.46$) and the city (2.70 correct responses, $SD = 0.63$) condition.

Discussion

Much research shows that duration judgments reflect the amount of information contained in the stimulus, perceiver's familiarity with the stimulus, and the demands placed upon the perceiver. This study highlights another, little researched, factor affecting such duration judgments: the meaning attributed to the stimulus. In our design both the stimulus itself and the participants' personal attributes remained constant across conditions, which allowed us to test whether simply attributing the sound to one context rather than another could impact upon duration reproduction. The results obtained in the single task conditions show it did: attributing the sound-clip to the Mela resulted in longer reproductions than when attributing it to city streets. While both source attributions (Mela and city) have general social meanings for our participants, the mela-attribution gives the sound-clip a meaning relevant to their particular goals (a focus on the spiritual) in the given social context. It should be noted that mela pilgrims are exposed to religious as well as traffic sounds in the Mela.

The social meaning effect echoes the result reported by Srinivasan et al. (2013). However, the present data extend that work in significant respects. First, we showed that the effect obtains in both retrospective (Srinivasan et al., 2013), and now here, in prospective paradigms. The fact that our effect of social labeling obtains in two different paradigms is important because it attests to the effect's robustness. The magnitude of the social labeling effect in the two studies is similar; 3.58 seconds in the Srinivasan et al. (2013) study and 3.43 seconds in the current study. Much research shows that these two paradigms impact duration reproductions in different ways (although see Klapproth, 2007) with memory processes playing a critical role in retrospective paradigms and attentional processes in prospective paradigms (Block & Zakay, 1997). The similarity of the effect suggests the presence of a common mediating factor in both studies. The social meaning might influence processing

resources needed for richer encoding and this might be responsible for the similar outcome with both paradigms.

Second, the data reported here shows that the effect is dependent upon participants having attentional resources available. Attentional processes feature prominently in prospective paradigms (Block & Zakay, 1997; Brown, 2010; Phillips & Cross, 2011; Tobin, Bisson, & Grondin, 2010), and manipulations that influence the allocation of attention (such as when one is faced with a concurrent secondary task), result in shorter duration reproductions (Brown, 2008; Grondin, 2010). The use of a prospective task and conditions featuring a concurrent second task enabled us to show that the effect of social labelling of the stimulus was contingent upon having attentional resources available. Labelling the sound as Mela-related only increased reproduction durations when attentional load was low implying that enough attentional resources are needed for the effect of interest to occur. Indeed, the fact that the effect of social meaning (Mela vs. city) was nullified (rather than merely attenuated) in the dual task conditions is striking. It may be tempting to explain this absence of the effect in the dual task conditions in terms of a floor effect. However, it is appropriate to note that in these conditions participants' duration estimates were very similar to the baseline durations obtained in other research using a 20 second sound-clip (Eisler & Eisler, 1994; Srinivasan et al., 2013).

Third, our effect highlights the complex ways in which attentional processes affect duration estimates. Participants in prospective paradigms can intentionally allocate attention to both temporal and non-temporal information (Thomas & Weaver, 1975; Zakay & Block, 1996). Yet, the data from our single task conditions show that even though participants knew they would be asked to reproduce the stimulus's duration (and so could be expected to allocate attentional resources to processing temporal information), their duration reproductions were still affected by the labelling of the sound's origin. This shows that even

when participants seek to attend to temporal information, the meanings associated with a stimulus can impact upon its processing by making processing easier (knowing the social meaning helps to process an ambiguous stimuli) such that more temporal information is available resulting in longer duration reproductions.

With regard to the wider significance of these data we know a person's socialization and experiences can shape their perception of the relevance (and subsequent processing) of stimuli (Chavajay & Rogoff, 1999; Kitayama, Duffy, Kawamura, & Larsen, 2003). For example, meditation training influences attentional mechanisms (Raffone & Srinivasan, 2010; Baijal, Jha, Kiyonaga, Singh, & Srinivasan, 2011). Practitioners of a particular religion tend to process information in accordance with the cognitive strategies that they typically employ in religious contexts (Colzato, Hommel, & Shapiro, 2010; Hommel & Colzato, 2010). To the degree that such cultural experiences affect attentional processes, we can expect individual differences in time perception. Our work complements this literature on individual differences in cognitive-processing by emphasizing the point that the *same* stimulus can be attributed different social meanings and that this can be consequential for the experience of time.

Our research also highlights the complex ways in which attention impacts temporal judgements adding to the exisiting literature on attention-based effects on time perception. Typically, researchers have considered how participants may be distracted and their attention attenuated as a function of stimulus content. For example, Gil, Rousset and Droit-Volet (2009) explored how the valence of stimuli (in this case whether a food was liked or disliked) affected participants' judgements of the stimuli's exposure. They found that compared to a neutral stimulus, such times were underestimated to a greater degree for disliked than liked foods. The authors interpret this in terms of attentional mechanisms and suggested that disliked food items distracted attention away from the processing of temporal information.

Our work complements such work in important respects. Most obviously, whereas Gil et al varied the stimulus content ('liked' foods included items such as 'cream cake' and 'disliked' foods included items such as 'blood sausage'), we kept the stimulus constant. Less, obviously but more importantly, whereas Gil et al (2009) show that some stimuli (e.g., foods that are disliked) distract attention (because they lead to thinking about the foods' health-related dangers), we show that the labelling of a stimulus may enable richer processing with less resources resulting in longer duration judgments.

While the specific context for our research (a noisy religious festival) provided us a unique opportunity to study how the social labeling of sounds impacted upon their processing, our study has certain limitations. Some concern the sample: our participants only included older, male, pilgrims. Some concern the stimulus: given the complexity of running studies in the setting of the Kumbh Mela, we only explored duration reproductions for a single duration (20 seconds). However, a real merit of using one duration is that it allows comparisons with previous work on the social labeling of a sound's origins (Srinivasan et al, 2013), and in combination, these studies constitute clear evidence of a new effect that requires theorization. Srinivasan et al. (2013) argued that the longer reproductions obtained when the sound-clip was attributed to the Mela in their original (retrospective) study arose due to changes in attention as a function of labelling The present study more directly tests this reasoning. It shows the effect is robust and obtains in prospective as well as retrospective paradigms. Moreover, it shows the effect obtains in a paradigm where attentional processes play a key role and that the effect is affected by manipulations known to impact upon the availability of the cognitive resources required for information processing.

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List of Figures

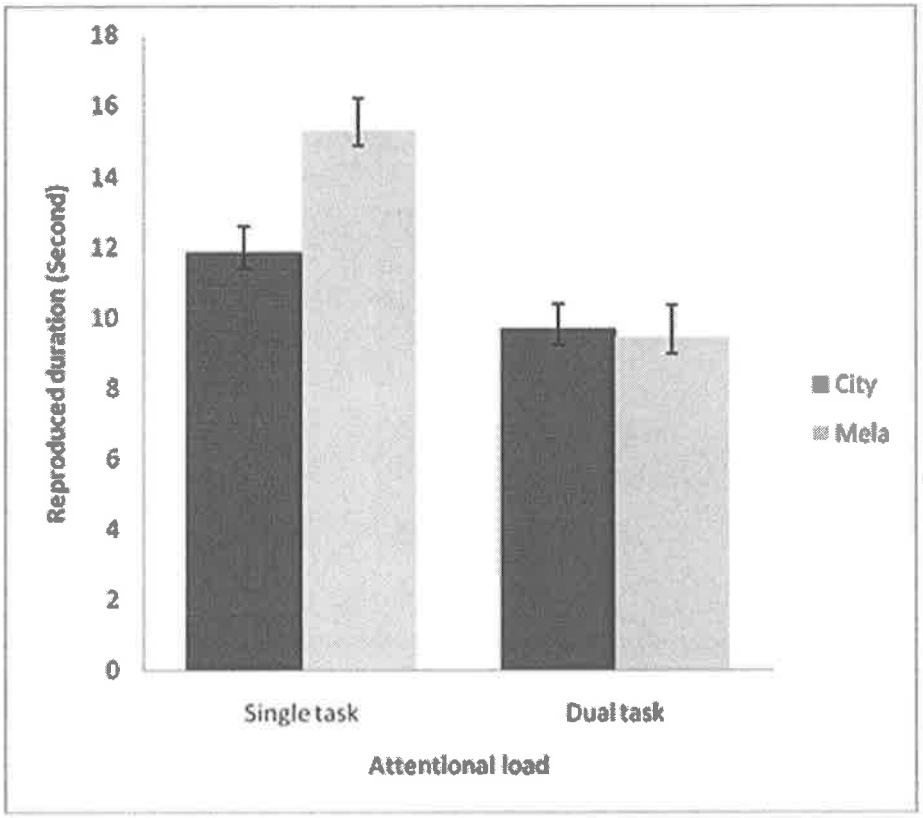
18
16
14
12
10
8
6
4
2
0
Reproduced duration (Second)
City
Mela
Single task
Dual task
Attentional load

Figure 1