THEOREM 2 One cannot form a soritical sequence in a regular well-matched space.

I make no claim that all empirical pairwise comparison data necessarily have the structure of regular well-matched spaces. My only claim is that there is no empirical evidence to the contrary, because of which the comparative sorites hypothesis is purely speculative. The idea that stimulus spaces are regular and well-matched is also largely speculative, but it has at least been tested for paradigms involving two observation areas. More importantly, it is conceptually much simpler, so it is a better candidate for a default, benchmark hypothesis.

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AGING AND WORKLOAD CAPACITY: DO OLDER ADULTS INTEGRATE VISUAL STIMULI DIFFERENTLY THAN YOUNGER ADULTS?

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Abstract
The effect of aging on response times and on the processing capacity of redundant-visual signals is a neglected theme in the study of aging. In the redundant target design (RTD), an observer detects the presence of a target. A trial can include two (redundant), single, or no-targets. Do older-adults integrate visual stimuli differently than younger-adults? A new approach to capacity (Townsend & Nozawa, 1995) compares the processing of single- and redundant-target trials to compute an index of workload capacity. We discuss the implication of various theories of aging on Townsend's capacity coefficient: Generalized cognitive slowing models with a single age-related slowing equation for all trials; Information degradation models linking sensory loss with cognitive tasks; and Models assuming a decrease in the efficiency of inhibiting distractors. Experimentally, we compare target-detection latencies and Townsend's capacity for younger- and older-adults in RTD, examining the effects of distractor presence and absence for both groups.

Consider the following situation: Mrs. Jones, an elderly pedestrian, is about to cross the road on a dark night. She looks to the left to spot an oncoming vehicle. A single signal (e.g., the front light of the vehicle) is sufficient to stop her from crossing. Two signals (e.g., two lights) constitute redundant superfluous information. However, there is a bulk of evidence to suggest a gain reaped in detection from the presence of multiple targets -- the Redundant Targets Effect (RTE). This speed up may be the result of mere statistical facilitation, or of an interaction in the processing of the two signals. How will the performance of the elderly person compare with that of her 20-year-old grandson, young Mr. Jones? It is reasonable to assume that he will make his decision faster than she will. An age-related slowdown of responses is a common result in many cognitive tasks. But, will the elderly person integrate the visual signals differently than her younger counterpart? In this study, for the first time, we compare the processing of visual redundant information between younger and older adults.

The situation on the road is mimicked in the laboratory via the well-known Redundant Target Design (RTD). Of the set of stimuli, one is defined as the target, and the other as the distractor. On each trial, the observer responds "Yes" when the display contains at least one target; otherwise she or he responds "No." Consequently, a trial in such a design can include two targets (redundant-targets displays), a single-target (single-target displays), or none (no-target displays). Townsend & Nozawa (1995) defined a measure of capacity, C(t), that gauges the extent to which target processing in one channel is impaired [C(t)<1, limited capacity], left unaffected [C(t)=1, unlimited capacity], or improved [C(t)>1, super-capacity] by adding a target in the other channel. Formally, the capacity coefficient C(t), is defined as $C(t) = H_{U,L}(t) / [H_U(t)+H_L(t)]$, t>0, where $H_U(t)$, $H_L(t)$, and $H_{U,L}(t)$ are the integrated hazard functions calculated in the single- and double-target trials, respectively (see Townsend & Nozawa, 1995, for explication). The subscripts U and L refer, respectively, to the upper and lower position of the target. In our study, we compared capacity coefficient values for older and younger adults. Larger regions of super-capacity (larger than unity values of C(t)) for older adults will imply that older adults are integrating redundant signals more efficiently than younger adults do. On the other hand, larger regions of severely limited capacity [C(t)≤0.5] for older adults, will imply that they are not only slower in their responses, but also less efficient in processing as the load of information (i.e., number of to-be-processed items) increases.

How will workload capacity change with age? Models of generalized cognitive slowing assume that "age-related reduction in some type of general-purpose processing resources contributes to impaired cognitive performance" (Salthouse, 1988). However, older adults performed with larger regions of super-capacity on a same-different judgment task (of color and shape, Gottlob, 2007) and on an audio-visual detection task (Hugenschmidt, et al., in press). This seemingly augmented capacity with age may be understood in the light of information degradation hypothesis (Schneider & Pichora-Fuller, 2000): Sensory declines with age directly affect performance, as the cognitive system has to deal with degraded information, but integration and processing may be unharmed (or even augmented) with age.

Let us get back to the road example. This time, Mrs. Jones is trying to cross a busy street. There are many other distracting (competing) signals in a visually complex scene. Mrs. Jones has to attend selectively to certain features in the environment that indicate the oncoming vehicle, while ignoring or actively suppressing others (e.g., pedestrians). According to Hasher and Zacks' (1988) theory of a decrease in the efficiency of inhibitory processes with aging, Mrs. Jones' performance in the busy road will be impeded to a larger degree than that of her young grandson. To mimic this situation, in our study, we compare the performance of both age groups in redundant target experiment with two conditions: (a) Distractor Absent -- in which a target letter can be presented for view either singly on one of two locations, on both, or none; And (b) Distractor Present -- in which the stimulus-set consists of a target letter and a distractor letter, such that the lack of a target letter necessarily implies the presence of a distractor letter. According to Hasher and Zacks' theoretical approach, a distractor in the display will hinder the performance of older adults to a much larger degree than that of their younger counterparts. Specifically, a distractor will tax responses on single-target trials for seniors more than it will for of younger adults, and consequently, larger RTEs for older adults in the distractor present condition ensue. This effect, however, marks the slowdown on single target trials (due to suppression from the distractor), rather than a true facilitation on double target trials. A different prediction is postulated by generalized cognitive slowing models, the same function dominates age-related slowing in all three different trials (redundant-target, single-target and no-target), both in the distractor-absent and the distractor-present condition.

Method

Participants. Six younger adults (M=21.3 years old, sd=3.4) and six older adults (M=71 years old, sd=3.2) participated in this study. The older adults were volunteers from the local community and the younger adults were undergraduates at UTM. By self report, all observers enjoyed good ocular health and had no history of visual pathologies. Snellen acuity (for binocular near vision) was measured with the participant wearing (when necessary) appropriate correction. Mean acuity, expressed as the denominator of the Snellen ratio, was 13.4 (SD=1.75) and 18.5 (SD=5.7) for younger and older adults, respectively [t(8)=1.7, p>0.05].

Stimuli, Apparatus, and Design. In the Distractor-Absent condition, the stimulus set consisted solely of the letter X (as the target), whereas in the Distractor-Present condition, the set consisted of the letter X as the target and the letter O as the distractor. All letters were Arial bold, font size 90, which, at a viewing distance of 60 cm, amounted to 2.43 degrees of visual angle. On a trial, a white rectangular frame (4.25" X 3.19") was presented at the center of the screen, in which a letter could appear above or below the center of the frame. In the distractor-present condition, 25% of the trials were no-target trials (O displayed at the top and bottom positions), 50% were single-target trials (X above O, or O above X), and 25% were double-target trials with X on both positions. In the distractor-absent condition, on 25% of the trials the frame was blank (no-target trials), in 50% the letter X appeared within the frame either at the top or bottom position (single-target trials), and in 25% of the trials, the letter X appeared on both the top and bottom positions (double-target trials). The stimuli were displayed white on a black background.

The participants were instructed to press one key ("Yes") if at least one of the letters in the display was the target (X) and another key ("No") if the target was not present. Trials were response terminated. The study consisted of two experimental sessions, each about an hour long, separated by 2-7 days. Each session consisted of two conditions: Distractor present and distractor absent. The order of these conditions was fully counterbalanced. Each experimental condition consisted of ten blocks, five in each session, 160 trials each (1600 trials per participant for each).

Results

Error rates did not differ significantly between conditions (F<1), however accuracy was a bit higher for older adults than for younger adults [99% vs. 97.9% respectively, t(10)=1.76, p=0.054]. Analyses of reaction time (RT) are restricted to correct responses. Responses speedier than 200 ms, and slower than 1,200 or 900 ms for older and younger adults, respectively, were discarded (less than 1%). We estimated, for each participant, the capacity coefficient function based on RT data. To assess the (in)stability of the estimated capacity function, we plot in thin dashed lines the confidence intervals of estimation (by bootstrapping; see Van Zandt, 2002).

Distractor Absent Condition. Mean response latencies are presented in the two left columns of Table 1. Note that average latencies for younger adults are 71 ms faster than for older adults [t(10)=2.28, p<0.05]. However, RTEs are similar for both age groups, and so were the patterns of the capacity coefficient function (Figures 1 and 2, solid line). Capacity values do not exceed unity significantly, implying lack of supercapacity.

Distractor Present Condition. Mean response latencies are presented in the two right columns of Table 1. Again, older adults initiated responses about 70 ms slower than younger adults [t(10)=2.54, p<0.05]. RTEs for older adults were 10 ms longer than for younger adults [t(10)=1.7, p=0.1]. Concomitantly, most older adults exhibit super-capacity for some time t, whereas none of the younger adults does so (Figures 1 and 2, dashed line).

Table 1: A summary of mean response latencies (in ms).

	Distractor absent		Distractor present	
	Younger adults	Older adults	Younger adults	Older adults
Double-target displays	375	448	395	466
Single-target displays with a favored target location[1]	383	455	413	494
No-target displays	476	541	499	576
Average RT	409	480	435	513
RTE	8**	7*	18*	28**

*p<0.05, ** p<0.01, RTE = RT(single-target with a favored target location) – RT(double target).
[1]For each participant we identified the favored target location, top or bottom.

Comparing Distractor Present and Absent Conditions. Overall, both age groups were slower in the Distractor-Present condition than they were in the Distractor-Absent condition (by 26 and 33 ms, F<1, for the younger and older groups, respectively).

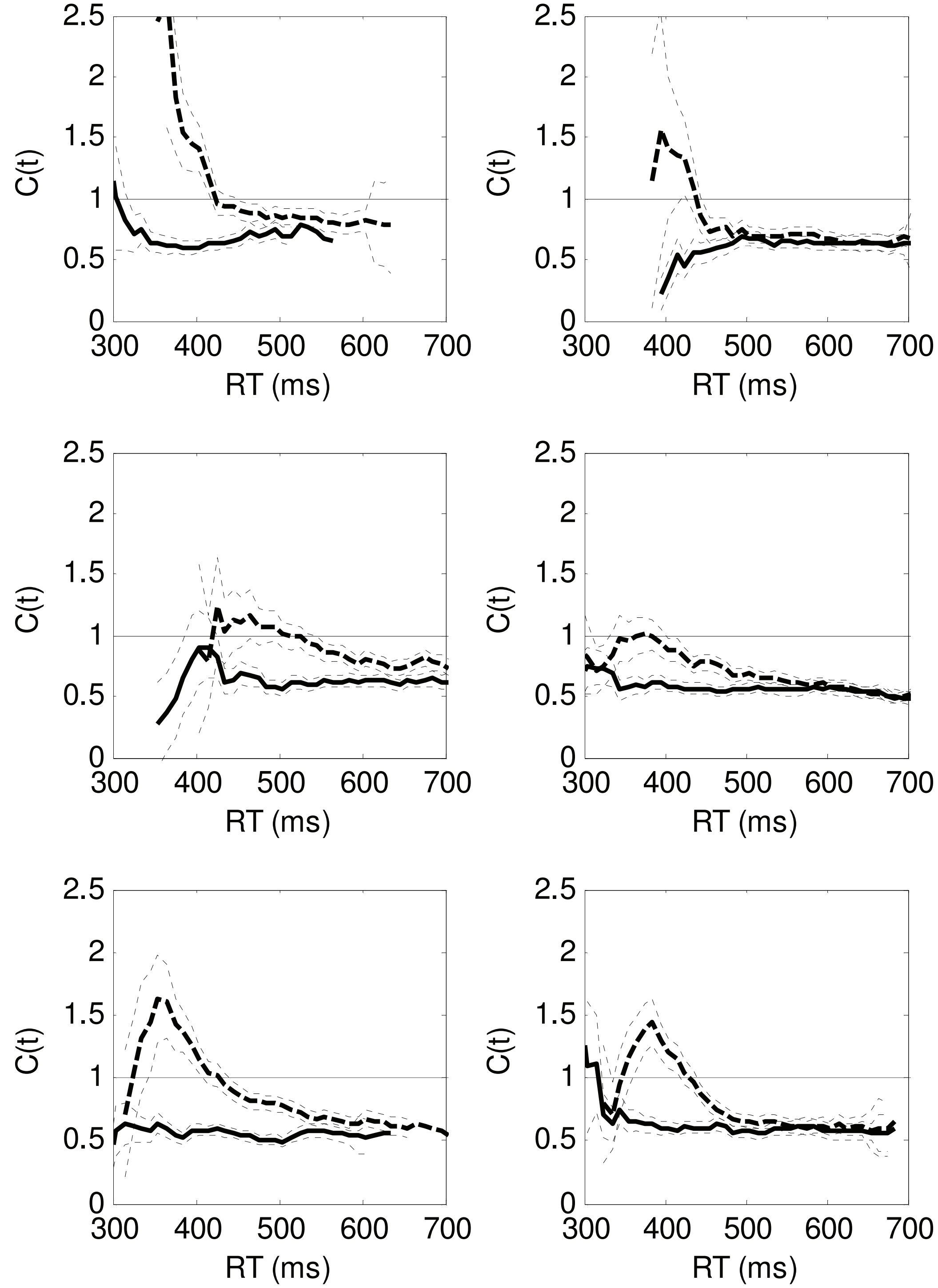

Figure 1. Capacity coefficient functions for six older adults in distractor absent (thick solid line) and distractor present (thick dashed line) conditions. The thin dashed lines represent confidence intervals.

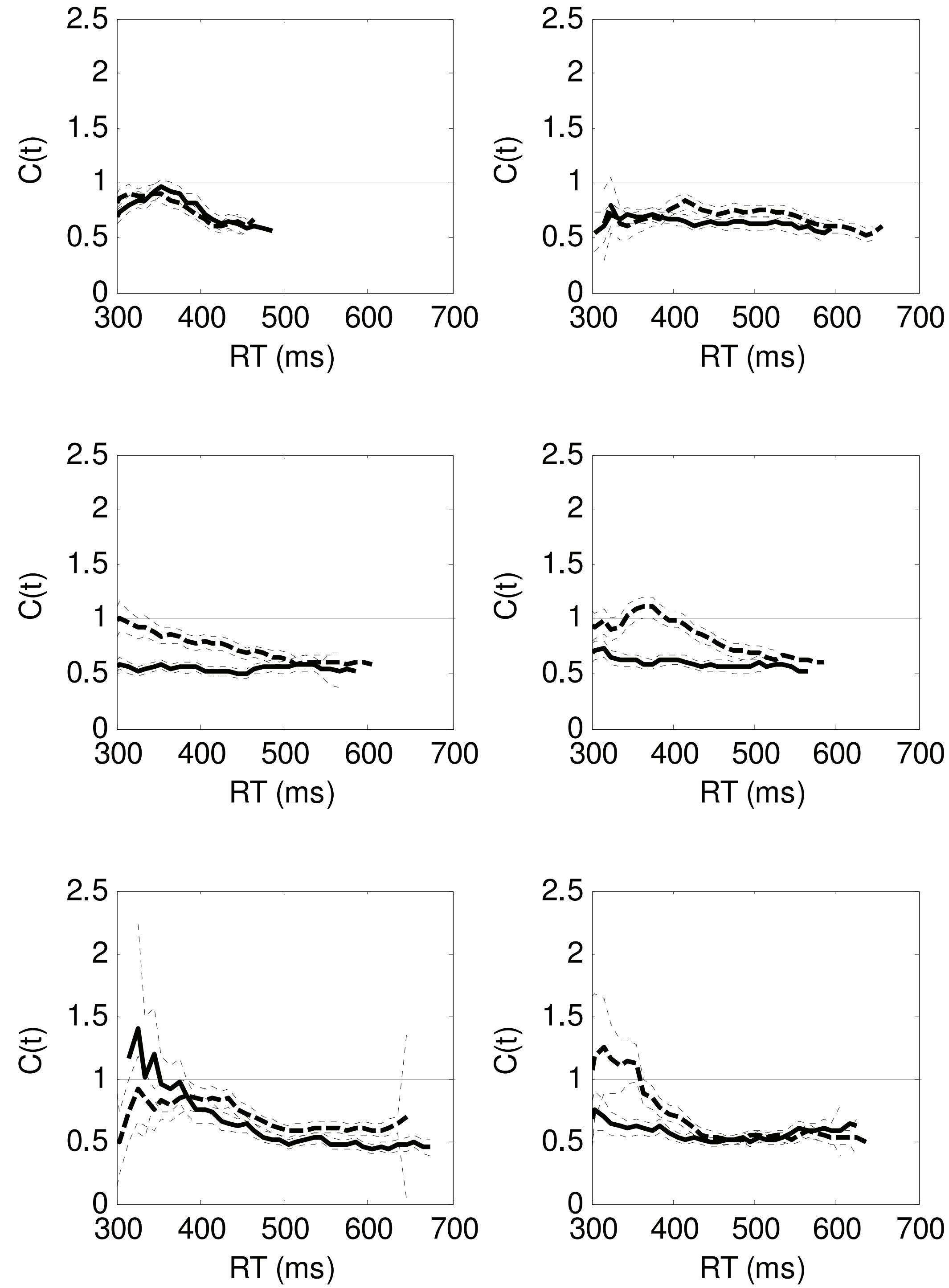

Figure 2. Capacity coefficient functions for six younger adults in distractor absent (thick solid line) and present (thick dashed line) conditions. The thin dashed lines represent confidence intervals.

The slowdown across tasks was about the same for both age groups on double target trials (20 and 18 ms), but not on single target trials: Younger adults were 30 ms slower when the single target display also contained a distractor, whereas older adults were 39 ms slower [F(1,10)=2.3, p>0.1]. Brinley plots (Brinley, 1965), in which latencies for older adults on a task are plotted as a function of latencies for younger adults on the same task, were fit by a straight line, for all three tasks in the two conditions. Therefore, our data is not sufficient to reject generalized cognitive slowing models, even if the data strongly suggest that this may be the case.

The presence of a distractor augmented the capacity coefficient values observed for older adults (Figure 1) more than it did for younger adults (Figure 2). None of the younger adults had exhibited significant super-capacity; the lower confidence bound of capacity coefficient function, with and without distractors never exceeded 1. In contrast, four out of six older adults exhibited significant supercapacity for the distractor-present (but not distractor-absent) condition. Notably, for *all* six older adults, the capacity function with distractor exceeded the capacity function without distractor, at least for some time t.

Summary and Conclusions

Elderly Mrs. Johns will make her decision to cross the street more slowly than her grandson. However, she may integrate redundant visual signals as efficiently as her grandson. A busy intersection, entailing distractors in a complex visual scene, will slow down both of them, but the effect of unwanted distractors would be more salient for Mrs. Jones. Further investigation is called for to retrieve the source of these age differences: Reduction in inhibitory processes, generalized cognitive slowing, or information degradation

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EFFECTS OF THE SOUND-PRESSURE-LEVEL DIFFERENCE BETWEEN CROSSING GLIDES ON THE OCCURRENCE OF THE GAP TRANSFER ILLUSION

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Abstract

A psychophysical experiment was conducted in order to examine the effect of the sound-pressure-level difference between crossing glides on the occurrence of the gap transfer illusion. The gap transfer illusion is an auditory phenomenon in which a temporal gap in a long glide is perceived as if it were in a short crossing glide that is physically continuous. It turned out that the gap transfer illusion takes place when the short glide is down to 8 dB below the level of the long glide. The results indicate that the subjective continuity of the long glide in the gap transfer illusion is different from the continuity in the continuity illusion, in which the masking potential of the interrupting sound is requisite.

When a long ascending or descending frequency glide with a gap at the temporal middle and a short continuous glide moving in the opposite direction cross at their central positions, observers report that a gap belongs to the short, instead of the long, glide (Figure 1). This phenomenon is called the *gap transfer illusion*, and is explained with *auditory subevents* such as onsets and terminations (Nakajima, Sasaki, Kanafuka, Miyamoto, Remijn, & ten Hoopen, 2000). When the gap transfer illusion takes place, onsets and terminations are detected at the temporal edges of the glides (Figure 1). The principle of proximity, one of the *Gestalt* principles, is applicable to these auditory subevents; an onset and a termination that are close to each other in frequency and time are likely to be connected perceptually to form an auditory event. In the stimulus pattern indicated in Figure 1, the onset and the termination preceding the gap are close to each other, and thus they are connected with each other. The onset and the termination succeeding the gap are connected as well. The residual onset and termination form a long continuous tone. Thus, the gap transfer illusion has been explained.

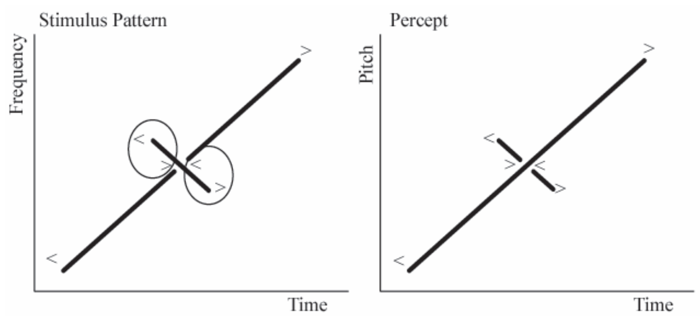

Figure 1. The gap transfer illusion and auditory subevents. The vertical axis shows logarithmic frequency or pitch and the horizontal axis shows time. Circles surround onsets (<) and terminations (>) that are connected with each other in perception.