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# Emotional interference in enumeration: A working memory perspective

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## Abstract

We investigated the influence of emotional stimuli on enumeration. On each trial a set of 1 to 10 affectively positive, negative or neutral words were presented for 200 ms each. Participants counted the words after each trial. Error was greater and response times were longer for negative and positive words than for neutral words. Most importantly, this effect was shown only for set sizes within the countable range (set sizes between 1 and 7 words), with no effect in error rates for sets of 1 to 3 items. The effect disappeared for set sizes in the uncountable range (i.e., 8 to 10 words). Results underline the important role of the central executive in enumeration.

Key words: Enumeration; Working memory; Affective valence

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When people are presented with a number of items to enumerate they engage one of two processes: subitizing or counting, depending on the number of to-be-enumerated (TBE) visual objects. The term *subitizing* (Kaufman, Lord, Reese, & Volkmann, 1949) refers to the fast, effort-free, and accurate enumeration of less than four items that produces virtually no errors. In subitizing, the number of objects can be “seen at a glance” without iterative processes. Counting, in contrast, is the relatively slow, effortful, and error-prone enumeration of more than four items which relies on serially adjusting one’s internal count upon perceiving an item. These different enumeration processes have been recognized for over a century (Jevons, 1871). Recent research has accumulated evidence on the temporal characteristics of subitizing and counting (e.g., Guttman, 1978; Lorinstein & Haber, 1975; Mandler & Shebo, 1982; Oyama, Kikuchi, & Ichihara, 1981), the subprocesses of subitizing (e.g., Watson, Maylor, & Bruce, 2005, Wender & Rothkegel, 2000), and the brain regions involved in subitizing and counting (Sathian et al., 1999).

Little is known, however, about the influence of TBE items’ characteristics on subitizing and counting. Oyama (1982) demonstrated that randomly composed items are more difficult to enumerate than systematically composed ones. Whalen et al. (1998) studied the role of affective valence. They did not find an *emotional interference effect*, expressed as differences in response time for enumerating negative words and neutral words when sets of 1 to 4 words were presented, although they showed different activation patterns for counting stroop tasks with non-emotional and emotional words, respectively, in the anterior cingulate cortex (ACC). Whalen et al.’s (1998) findings raise two important questions. Firstly, would an interference effect be found for larger item sets? Secondly, would a potential effect be found with positive stimuli, too?

The role of set size may be important given that the enumeration sub-process of subitizing has been described as effortless. Interference may thus not arise, accounting for the findings of Whalen and his colleagues. Counting, on the other hand, that is thought to be engaged for sets larger than four items, does require substantial cognitive capacity and may thus be prone to interference. Such interference has in numerous studies been found with negative stimuli in a variety of effortful tasks (cf. Schimmack, 2005). Threatening stimuli make it difficult to disengage attention from the stimulus (Fox, Russo, Bowles, & Dutton, 2001, Gotoh, 2008). Negative distractors hinder performance more than neutral distractors (Eastwood, Smilek, & Merikle, 2003).

The second question pertains to a differentiation that has recently become a focus of research. Whilst earlier theories posited a *negativity bias* assuming that negative, but not positive stimuli interrupt processing due to their relevance for survival (e.g., Pratto & John, 1991), more recent approaches conceptualize interference as being moderated by the arousal from emotional stimuli (cf. Verbruggen & de Houwer, 2007). In this view, positive and negative stimuli alike will capture attention if they induce sufficient arousal. The present experiment addressed these questions using affectively valenced words as TBE items. Our basic assumption was that emotional stimuli will usurp attentional capacity, which might interfere with enumeration. We manipulated the number of TBE items and valence to test for set size and arousal effects.

We posit that limited working memory will have to be taken into account when modeling the influence of emotional stimuli on enumeration. Working memory refers to a cognitive system concerned with both the storage and the processing of information. Its capacity to run these operations is limited (e.g., Baddeley, 1998). A central executive “supervises” processing, focusing attention on relevant information and inhibiting irrelevant information. In this view, the central executive is responsible for enumeration with its sub-processes of calculating the number of items, maintaining the result of the calculation, and separating not yet counted items from already counted items. Since a central executive controls the focus of attention (Cowan, 1995), emotional connotation usurps attentional capacity if TBE items involve important and unavoidable – although irrelevant – features, In light of the two kinds of enumeration described above, effortful counting performance reflects the influence of stimulus attributes on the central executive. In line with this reasoning, Tuholski, Engle, and Baylis (2001) obtained performance differences as a function of working memory span for counting, but not for subitizing.

In our experiment, we focused on the role of the central executive and of general limited capacity in working memory. We presented stimuli for a short duration and masked them immediately. This served to trigger working memory involvement, as active processing will be needed to maintain the short-lived iconic image of stimuli beyond the mask. If only maintained items can be enumerated, the limits on working memory will influence performance. The number of items that can simultaneously be held in working memory has been put at anywhere between about four and about seven items (cf. Cowan, 2001; Miller, 1956). Consistent with the subitizing-enumeration divide, Mandler and Shebo (1982) found that the effect of stimulus display duration on enumeration performance varies with set size. They analyzed enumeration tasks with set sizes from 1 to 20 items. For response times, differential effects were found for sets of up to four and up to eight items, respectively. Effects declined for larger sets. Similarly, differential effects were found on error rates for sets of up to four and up to eight items. Effects diminished for sets of eight to eleven items and disappeared for more than 11 items. According to Cowan (2005), these data can be explained by three regions: a subitizing region (about 1 to 4 items), a counting region (about 4 to 8 items), and an estimation region (more than eight or so items). Taking Mandler and Shebo's (1982) results, there appears to be a countable region (about 1 to 6 or 7 items) involving the subitizing and counting regions, and an uncountable estimation region (more than 8 items). In terms of stimulus processing, the countable region is likely to be crucial. In the countable region, participants might be able to recognize each stimulus and process word connotation, enabling them to give the correct answer. In the uncountable region, however, participants might not be able to recognize every single stimulus, limiting the influence of connotation on the central executive. Therefore, stimulus valence might impinge on enumeration in the countable, but not the uncountable region.

Based on these considerations, we treat sets of up to seven items as falling within the countable region and larger sets as being in the uncountable region. It seems unlikely that a significant emotional interference effect will be found for more than eight items. We expect that emotional stimuli will only interfere with enumeration if set sizes are in the countable region. Under these circumstances, cognitive resources are left for attending to stimulus connotation, possibly resulting in attention dwell. However, in the uncountable region, processing stimulus meaning would exceed resources, which will therefore be focused on the primary task of enumeration. Therefore, the interference effect will disappear for uncountable region.

## Method

We presented single-character Kanji words as TBE items. Participants were asked to enumerate the words displayed in sets from 1 to 10. We analyzed response times and error rates separately for the countable (i.e., 1 to 7 words) and the uncountable regions (8 to 10 words). In addition, we analyzed response times and error rates for subitizing and counting in the countable region. We also analyzed the difference on errors between set sizes 7 and 8 to assess if different mechanisms may underlie processing in the countable and uncountable regions, respectively. In order to explore the role of arousal, we gathered arousal ratings for all stimuli and compared sets of negative, neutral, or positive valence, respectively.

*Participants.* Twenty-three undergraduate students (11 women and 12 men) participated in the experiment. All were native Japanese speakers with a mean age of 23.0 years ($SD$ = 0.9) and reported being right-handed and normal or corrected-to-normal vision.

*Materials.* Forty-five single Kanji words (15 negative, 15 neutral, and 15 positive) were used as TBE items. The average valence ratings were 5.92, 3.94, and 1.92 for negative, neutral, and positive words, respectively, on a 7-point scale with 1 as the positive end. On a 7-point scale with 1 as the low end, the average arousal ratings were 4.32, 2.28, and 4.88 for negative, neutral, and positive stimuli, respectively. Ratings differed significantly for positive and negative stimuli, $t(14) = 2.25$, $p < .05$. Word frequency was controlled for based on the norms of the National Language Research Institute (2002) and the number of Kanji strokes per word was kept virtually equal between valences, $F(2, 28) = 0.76$, n.s., $F(2, 28) = 0.03$, n.s., respectively.

The size of enumeration sets ranged from 1 to 10. Eighteen filler sets of 11 and 12 words were used to prevent participants' guessing on trials with large sets. Figure 1 shows stimulus examples and the mask. Fillers were excluded from the analyses. Words were arranged in a 10 x 10 matrix. Words were assigned to their individual locations by random numbers. Three raters judged the word arrangements; arrangements which were unanimously judged as non-random (e.g., if forming patterns such as triangles or crosses) were not used for display. Each set size could appear in one of fifteen patterns, and one of three valences with different words, yielding 45 patterns per set size. Each word appeared in white on black background and subtended a visual angle of approximately 0.8 degrees within a frame of 10.7 x 10.7 degrees at a viewing distance of 50 cm.

*Procedure.* Participants were tested individually in two sessions, each lasting about 30 minutes and with a break of at least 70 minutes. Participants were seated in front of a computer screen at a distance of 50 cm with their chins fixed on a head support. Participants


**Figure 1:**
Examples of the stimulus (left) and mask (right) displays.

were instructed to enumerate the words as quickly as possible whilst maintaining accuracy. Participants started a trial by pressing the space bar. After a fixation cross for 1,000 ms, an enumeration set was presented for 200 ms followed by a mask for 200 ms. Each enumeration set contained words of the same valence only. Finally, a question mark serving as a response cue was shown until participants gave a response. Participants said the numbers of presented words, answers were recorded, and response times (RT) were measured by voice key to the nearest millisecond. In each session, participants were given 20 practice trials. Across sessions, they were given 468 experimental trials (3 valence x 10 set sizes x 15 patterns, plus 18 filler sets). Trials were presented in 8 blocks, with valence and set sizes distributed equally across blocks.

## Results

Data from two participants were discarded due to an excessive number of error trials indicating non-comprehension of the experimental instruction. Error and outlier trials (RT of more than the 1.5 interquartile ranges in each valence x set size condition) were removed from the data (approximately 2.6%). From the remaining trials, mean RT was computed per condition.

On the background of the aforementioned distinction of three ranges (subitizing, counting, and uncountable (estimation)) we assessed the processing differences by analyzing response times (RT) and error rates for set sizes of up to four items (subitizing range), of five to seven items (counting range), and compared response times and error rates for set sizes 7 and 8, which might mark the "transition" between the countable and uncountable regions.

To assess whether different cognitive processes underlie the countable and uncountable regions, we first conducted a MANOVA on RT and error with *valence* (negative, neutral, and positive) and *region* (countable and uncountable region) as within-subject factors. This analysis yielded a significant main effect of valence, $F$ (4,17) = 120.21, $p < .05$, a significant main effect of regions, $F$ (2,19) = 154.07, $p < .05$, and a significant interaction between valence and regions, $F$ (4,17) = 108.50, $p < .05$. The interaction suggests that the countable and uncountable region depend on different cognitive processes both for RT and error. Thus, we conducted a series of ANOVA on the subitizing and counting ranges of the countable region and the uncountable region, respectively.

### *Countable region – subitizing range (1 to 4 items)*

*RT data.* Figure 2 indicates the mean RT for subitizing as a function of affective valence. An ANOVA on RT with *set size* (1 to 4) and *valence* (negative, neutral, and positive) as within-subjects factors revealed a significant main effect of affective valence, $F(2,40)$ = 3.83, $p < .05$, a significant main effect of set size, $F(3,60) = 36.90$, $p < .05$, and no significant interaction between valence and set size, $F(6,120) = 1.71$, n.s. Planned $t$-test revealed that RT were significantly longer with negative ($M$ = 997, $SD$ = 217) and positive valence ($M$ = 997, $SD$ = 223) than with neutral valence ($M$ = 982, $SD$ = 221); $t(20) = 2.52$, $p < .05$, $t(20) = 2.50$, $p < .05$, respectively.

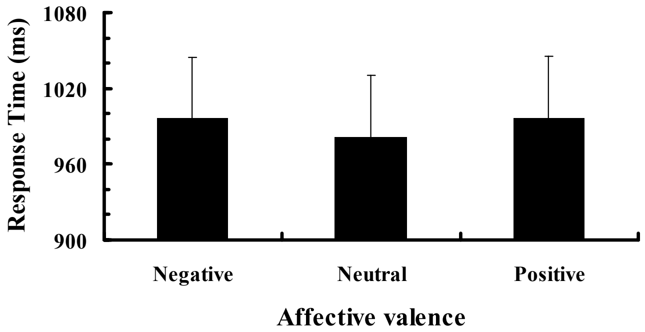


**Figure 2:**
Mean response times (in ms) with subitizing as a function of valence. Bars indicate SEM.

*Error data.* Zero errors were made for set sizes 1 to 2 for negative and neutral words and 1 to 3 for positive words, precluding an ANOVA for *set size* (1 to 4) and *valence* (negative, neutral, and positive). Error rates were $M = .009$, $SD = .016$, $M = .002$, $SD = .008$, and $M = .006$, $SD = .010$, for negative, neutral, and positive words, respectively.

*Countable region – counting range (5 to 7 items)*

*RT data.* Figure 3 shows the mean RT with counting range as a function of valence. An ANOVA on response time with *set size* (5 to 7) and *valence* (negative, neutral, and positive) as within-subjects factors revealed a significant main effect of valence, $F(2,40) = 4.75$, $p < .05$, a significant main effect of set size, $F(2,40) = 168.79$, $p < .05$, and no significant interaction between valence and set size, $F(4,80) = 1.36$, n.s. Planned *t*-tests revealed that

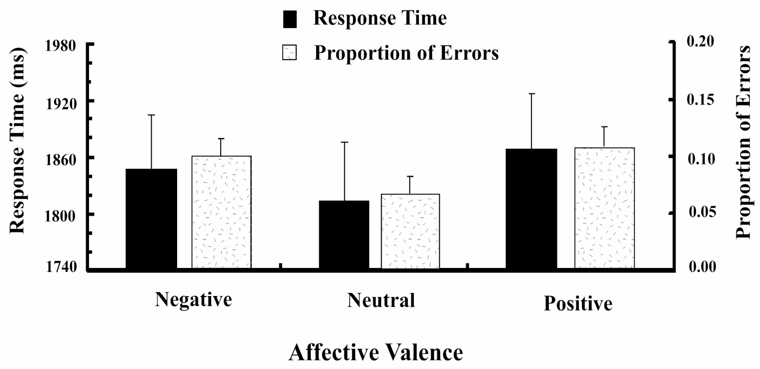


**Figure 3:**
Mean response times (in ms) and mean proportion of errors with counting as a function of valence. Bars indicate SEM.

response times were significantly longer with negative ($M$ = 1848, $SD$ = 258) and positive valences ($M$ = 1869, $SD$ = 267) than with neutral valence ($M$ = 1814, $SD$ = 285); $t(20)$ = 1.95, $p < .10$, and $t(20)$ = 3.05, $p < .05$, respectively. Thus, affective valence prolonged RT longer within the counting range.

*Error data.* Figure 3 displays the mean error within the counting range as a function of valence. An ANOVA on error with *set size* (5 to 7) and *valence* (negative, neutral, and positive) as within-subjects factors revealed a significant main effect of valence, $F(2,40)$ = 18.04, $p < .05$, a significant main effect of set size, $F(2,40)$ = 9.89, $p < .05$, and no significant interaction between valence and set size, $F(4,80)$ = .36, n.s. Planned $t$-tests revealed that error rates were significantly greater with negative ($M$ = .10, $SD$ = .07) and positive valence ($M$ = .11, $SD$ = .08) than neutral valence ($M$ = .07, $SD$ = .07); $t(20)$ = 4.35, $p < .05$ and $t(20)$ = 3.66, $p < .05$, respectively. Thus, affective valence induced more errors than neutral valence with counting range.

### *Countable/Uncountable region*

We first explored error rate differences between set sizes 7 and 8, which we assumed to mark the border between the countable and uncountable regions. A paired $t$-test of mean error at set sizes 7 ($M$ = .14, $SD$ = .12) and 8 ($M$ = .30, $SD$ = .13) on the three affective valences yielded a significant difference, $t(20)$ = 5.85, $p < .05$. Furthermore, we explored error rate differences between set sizes 1 to 7 ($M$ = .04, $SD$ = .03) and set size 8, which were significant, $t(20)$ = 10.03, $p < .05$; error was greater with set size 8 than with smaller sets. These results might reflect differences in underlying cognitive process, indicating that larger sets depend on estimation which induces more error.

*RT data*: Since the analysis yielded an interaction between the countable (1 to 7) and uncountable (8 to 10) regions and valence, the interaction was assessed. Further analysis revealed a significant main effect of affective valence at the countable region, $F(2,40)$ = 8.68, $p < .05$, and planned $t$-test showed that negative ($M$ = 1362, $SD$ = 206) and positive ($M$ = 1370, $SD$ = 215) valences were greater than neutral valence ($M$ = 1338, $SD$ = 219), $t(20)$ = 2.70, $p < .05$, and $t(20)$ = 3.93, $p < .05$, respectively. However, a main effect of valence at the uncountable region did not reach significance, $F(2,40)$ = 1.08, n.s. negative ($M$ = 2966, $SD$ = 504), neutral ($M$ = 2946, $SD$ = 480), positive ($M$ = 2913, $SD$ = 518). Thus, affective valence did not influence RT with set sizes at the uncountable region. Figure 4 shows the mean RT at countable as a function of valence, and Figure 5 shows the mean RT at uncountable as well as.

*Error data*: Like for RT, we analyzed the error data in more detail to explore the influence of affective valence on the countable and uncountable regions. Analysis revealed a significant main effect of valence at the countable region, $F(2,40)$ = 10.80, $p < .05$, and planned $t$-tests showed that error was greater with negative ($M$ = .05, $SD$ = .04) and positive ($M$ = .05, $SD$ = .04) valences than with neutral valence ($M$ = .03, $SD$ = .03), $t(20)$ = 4.67, $p < .05$ and $t(20)$ = 2.92, $p < .05$, respectively. However, the main effect of valence at the uncountable region did not reach significance, $F(2,40)$ = .64, n.s., $M$ = .39, $SD$ = .11, $M$ = .41, $SD$ = .12, and $M$ = .39, $SD$ = .11, for negative, neutral, and positive valences, respectively. To illustrate these results, the Figures 4 and 5 show the mean errors at the countable and uncountable regions, respectively, as a function of valence. Thus, affective valence (negative and positive) induced more errors than neutral valence at the countable region and affective valence did not influence error rates at the uncountable region.

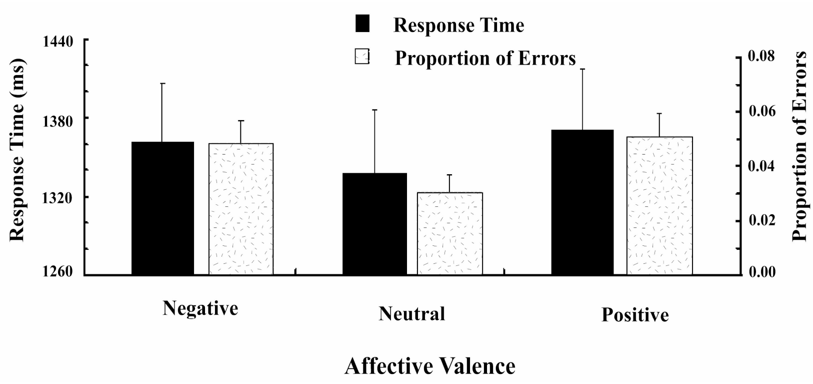


**Figure 4:**
Mean response times (in ms) and mean proportion of errors with enumeration at countable region as a function of valence. Bars indicate SEM.

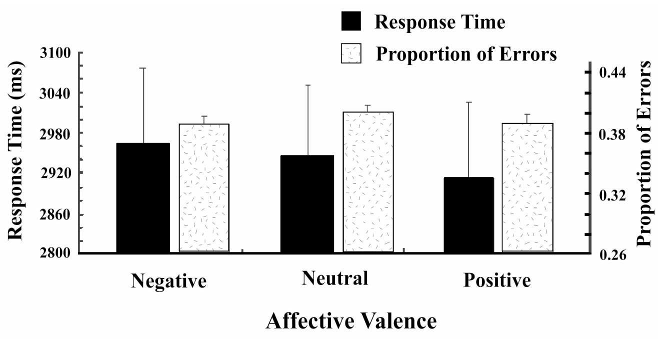


**Figure 5:**
Mean response times (in ms) and mean proportion of errors with enumeration at uncountable region as a function of valence. Bars indicate SEM.

## Discussion

In the present study, we examined from a working memory perspective whether emotional words as to-be-enumerated items influence the efficiency of enumeration. We found an emotional interference effect, expressed in longer response times for negatively and positively valenced words relative to neutral words. In addition, we obtained increased error rates with set sizes of five to seven items. In line with our expectations, emotional interference was restricted to set sizes within the countable range. As the interference effect did not differ between positive and negative words, we conclude that rather than valence alone, the arousal from emotional words creates interference. Whilst our findings are the first demonstration of an interruption effect on enumeration, they add to the recent results of Schimmack (2005) and Verbruggen and de Houwer (2007). In both studies it was shown that arousal moderates the effects of valence.

Recent studies suggest that the relation between attention and working memory is important for cognition. Central executive controls the focus of attention (Cowan, 1995) and attention is the “gatekeeper” for working memory to encode stimuli (Awh, Vogel, & Oh, 2006). Our findings suggest that since the central executive could not avoid the emotional connotation of the presented words, it attracts attention and interferes with ongoing executive function in the countable region. The attention dwell of emotional words is consistent with previous studies on working memory (Gotoh, 2008), or on the dot probe paradigm (Fox et al., 2001). In line with these findings, our study showed that not only negative valence but also positive valence attracts attention from working memory.

These results are also consistent with a trading-off view of cognitive resources allocation. Emotional stimuli distracted attentional resources from enumeration (e.g., for attention dwell). The amount of cognitive resource required increased with set size, prolonging response times and increasing error rates. At a set size around seven items, the cognitive load from enumeration and the processing of emotional meaning exceeded resources. In response, attention was shifted to enumeration alone to allow for carrying out this primary task. Attention dwell may be elicited in an automatic fashion, yet, it is under central executive control and may be regulated according to situational demands (cf. Müller-Plath & Pollmann, 2003).

It is important to note that this explanation differs from an activation-spread account of our data. This latter view would assume that an interruption effect will only be found if an overlap between the period in which the emotional meaning of the stimuli is still active in memory and the period in which enumeration processes are ongoing exists. For larger sets, activation may decay before enumeration is finished, explaining why the interruption effect disappears. However, as two reviewers have rightfully noted, it is less than plausible why activation should be so short-lived. One might assume that an interruption effect will only be found if sufficient resources are available for processing the emotional meaning of the stimuli, explaining why this interruption effect happens within the countable range. On the contrary, for larger sets, the central executive must allocate resource to enumeration, leaving insufficient resources for processing emotional stimulus meaning. In line with this reason, the executive can not enumerate correctly, providing grate errors for enumeration. Under this situation, it unlikely that executive can process emotional meaning of the stimuli. Our results clearly show that countable range can process the emotional meaning of the stimuli.

The number of around 7 or 8 is so-called “span of attention” (Woodworth & Schlosberg, 1954). The span of attention is calculated by 50% of correct answer of a single brief presentation and then refers to the correctly perceived number more than 50%. According to Oyama (1982), the mean number of span of attention is around 7 or 8. If this may indicate a threshold for cognitive resource or attention, our result of countable region may be also a threshold for processing meaning of the words in a single brief presentation.

In order to explore the subitizing and counting in countable region, we analyzed the data separately. We found that times were longer when participants subitized negative and positive words than neutral words. We also found that times were longer when participants counted negative and positive words than neutral words, although it was marginally significant between negative and neutral words. Errors were greater when participants counted negative and positive words than neutral words. The results of response time show that affective valence influenced both subitizing and counting in countable region. On the other hand, the results of error show that affective valence influenced on counting only. The interruption effect on counting supports our prediction, indicating that emotional stimuli influenced the very processing, leading to error.

The interruption effect on subitizing may seem to run counter to the assumption that subitizing is automatic processing (Tuholski et al., 2001), in which case emotional stimuli should not interfere with processing. Emotional stimuli influenced response times, but not error with subitizing, whereas they influenced both response times and error with counting. This may be taken to indicate that in subitizing emotional stimuli interfere with responding, rather than with the very processing of stimuli. Given the attention dwell on emotional words, participants may have automatically and with perfect accuracy identified the number of items. However, as a consequence of attention dwell, they delayed their response. Although this explanation can explain the results, future studies will have to test this tentative explanation.

The result of subitizing is also in contrast to emotional counting stroop task findings, where no behavioral effects of emotional stimuli were found (Whalen et al., 1998). Although subitizing in our experiment and the emotional counting stroop task are very similar in terms of set sizes and participant instructions, there is an important difference in the arrangement of stimuli. In our experiment, different words were randomly arranged in a 10 x 10 matrix. In the emotional counting stroop task, however, identical words were arranged in rows (Whalen et al., 1998). Unlike Whalen and colleagues, we used different words in the same display. Identical emotional word display may show weaker impact of emotional meaning than a display of different emotional words. In addition, the kanji words we used are ideographs allowing for direct access to word connotation. This may cause the different results.

As discussed above, we explain the results from the view of working memory function; however, the capacity limitation is also important. Concerning working memory capacity, Cowan (2001, 2005) proposed 4 rather than 7, referring to subitizing as one of evidences for the new limitation. According to this, counting processing (5 to 7 items) must be under online rehearsal, chunking, or memorization. If it is the case, these strategies are an effortful and resource consuming process, and then the interruption effect may be induced, making response time longer and error greater. In contrast, in the capacity limitation or subitizing, the processing does not seem to be effortful processing, showing the interruption effect on delayed response time but not on error. This explanation is consistent with previous studies. Controlled counting involves a number of stages, including keeping track of focus of attention, planning, and inhibition (Trick & Pylyshyn, 1994).

Another topic for upcoming research will be the relationship between valence and arousal. We found the above-reported interruption effect independent of stimulus valence, indicating that valence alone has not caused interference. At the same time, arousal was significantly stronger from positive than from negative stimuli. This may be interpreted in terms of threshold model: emotional stimuli will distract attention and interrupt processing in an all-or-none fashion once a threshold of arousal has been reached; more arousal will not lead to more interruption. Alternatively, from the perspective of an evolutionary threat account of emotional stimulus effects (e.g., Öhman, Flykt, & Esteves, 2001), negative items may due to their valence alone – which indicates relevance for survival – distract attention. They might thus need less activation to interrupt processing. Positive stimuli, on the other hand, are evolutionary more "neutral" and will only lead to interruption given sufficient arousal. In this case, valence and arousal would be seen to interact. Future studies could attempt to disentangle threshold and interaction accounts of arousal effects.

In conclusion, the present study demonstrates the influence of emotional stimuli on enumeration. The finding that emotional interference effects were found for set sizes at countable region, involving subitizing and counting, only underlines the important role of the central executive of working memory, and may serve as a starting point for further research on the influence of emotional stimuli on enumeration.

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## Appendix

The Kanji characters used as TBE items

| Affective Valence | | | | | |
|---|---|---|---|---|---|
| ***Negative*** | ***(meaning)*** | ***Neutral*** | ***(meaning)*** | ***Positive*** | ***(meaning)*** |
| 傷 | injury | 室 | room | 良 | good |
| 殺 | kill | 普 | normal | 恋 | love |
| 嫌 | dislike | 版 | plate | 喜 | delight |
| 病 | illness | 側 | side | 夢 | dream |
| 血 | blood | 査 | investigation | 快 | pleasant |
| 害 | harm | 紙 | paper | 幸 | luck |
| 非 | wrong | 符 | mark | 華 | gorgeous |
| 悪 | bad | 画 | stroke | 晴 | clear |
| 汚 | dirty | 章 | chapter | 福 | fortune |
| 悲 | sad | 垣 | fence | 祝 | celebration |
| 敗 | loss | 週 | week | 宝 | treasure |
| 死 | death | 規 | standard | 笑 | laugh |
| 苦 | pain | 析 | subdivision | 尊 | noble |
| 弱 | weakness | 階 | floor | 望 | wish |
| 痛 | hurt | 板 | board | 秀 | excel |