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The Spacing Effects in Memory and Individual Differences in Emotional Intelligence

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Abstract

Participants were presented with targets on two occasions. Each time, participants were asked to generate a past episode associated with the targets and judge the pleasantness of that episode during an orienting task, followed by an unexpected free recall test. For participants with high emotional intelligence (EI), the spacing effect (i.e., the advantage of spaced over massed presentation) was observed for targets associated with both pleasant and unpleasant episodes. For participants with low EI, that effect was found for only targets with unpleasant episodes. These results suggest that pleasant episodes elicited weaker emotional encoding than unpleasant episodes did. Furthermore, participants with high EI could activate emotional encoding elicited by pleasant episodes even if the emotion was not strongly experienced.

Key Words : *emotional intelligence, spacing effect, incidental memory*

1. Introduction

We often work without breaks, but performance of such conditions is generally ideal. However, if we added breaks between work period, performance could be better. As mentioned above, we need break intervals between periods of the same type of work. In the experimental research, the effects of break intervals on memory and learning have been examined for several years. For example, when a target (to-be-remembered word) is presented twice, the number of interpolated items between the two target presentations is critical to recall performance. Spaced presentation (i.e., that with interpolated items between repeated presentations) leads to better recall than massed presentation with no interpolated items. This advantage of spaced over massed presentation is described as the “spacing effect.” Several studies replicated the spacing effect for memory of verbal material, such as words (Kitao, 1983), text (Dempster, 1986), phrases (Glover & Corkill, 1987), and sentences (Rothkoff & Coke, 1966; Toyota & Kikuchi, 2004, 2005). Kitao (2002) also reviewed several studies assessing the encoding variability hypothesis (Martin,1968; Madigan, 1969; Gartman & Johnson, 1972; Glenberg, 1977; Kitao, 1983), which states that spaced presentation facilitates encoding variability between the first and the second presentations; however this is not the case for massed presentation. Although it is uncertain whether the encoding variability hy-pothesis is the most valid way of explaining the spacing effect (Kitao, 2002), it is known that spaced presentation facilitates rich encoding (Toyota & Kikuchi, 2004, 2005). The present study also examines the spacing effect in incidental memory from the view that spacing effects are determined by the richness of encoding.　Toyota (1987) reviewed several studies examining memory elaboration. In this context, elaboration refers to rich encoding, namely adding information to each target.　Tulving (1972) proposed the distinction of semantic versus episodic memory. According to this distinction, semantic elaboration refers to retrieval of added information from semantic memory, whereas autobiographical elaboration refers to retrieval of information from episodic memory. Warren, Chattin, Thompson, and Tomsky (1983) originally proposed the concept of autobiographical elaboration, which entails encoding personal episodes to specific targets. Toyota (1997) has conducted research comparing the effects of autobiographical elaboration with those of semantic elaboration, which entails encoding semantic information based on incidental free recall. The result showed that autobiographical elaboration was more effective than semantic elaboration in incidental free recall. In another study, the effectiveness of autobiographical

elaboration was determined by emotional encoding of personal episodes to specific targets (Toyota & Kono, 2006). Specifically, targets associated with personal episodes that created emotional reactions (i.e., either pleasant or unpleasant ones) were recalled more often than those that were not.

Emotional encoding has recently become an important topic in memory research. Particularly, several studies have reported that emotionally arousing events are recalled more often than are neutral events. Talmi, Schimmack, Paterson, and Moscovitch (2007) termed this phenomenon emotionally enhanced memory (EEM). EEM has been explored in a number of studies using emotional words (D'Argrembeau & Ver der Linden, 2004; Hamann, 2001; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002; Nagae & Moscovitch, 2002), pictures (Bradley, Greenwald, Petry, & Lang, 1992) and stories (Cahill & McGaugh, 1995). Toyota (2011) examined the relationship between emotional encoding and incidental recall, in a study in which emotional intelligence (EI) was used as an index of emotional encoding. EI is described as the ability to process emotions adequate, and the concept has received much research interest (e.g., Law, Wong, & Song, 2004). Salovey and Mayer (1990) suggested that EI is "the subset of social intelligence that involves the ability to monitor one's own and others' feelings and emotions, to discriminate among them, and to use this information to guide one's thinking and actions" (p. 189). This definition has been adopted in other research (e.g., Davies, Stankov, & Roberts, 1998; Mayer, Caruso, & Salovey, 2000a), albeit with minor alterations (Toyota, 2008). However the definition of EI can be divided in three categories: the ability model, mixed model and trait EI model. Mayer, Salovey and Caruso (2000b) favored the ability model, which considers EI as the ability to process emotions. According to the ability model, persons with high EI performed better than those with low EI in tasks associated with emotional processing. Contrary to the ability model, the mixed model adopts a broader definition that includes aspects of both abilities and traits, such as motivation and personality (e.g., Schutte, Malouff, Hall, Haggerty, Cooper, Golden, & Dornheim, 1998; Bar-On, 2000; Zeidner, Matthews, & Roberts, 2009). Further, the trait EI model focuses on the relationship between the personality traits and aspects of emotional function, such as empathy and assertiveness. Although these EI traits resemble conventional personality traits, the difference between trait EI and conventional personality depends on the relationship with emotional function. Some research (Davis & Kraus, 1997; Ciarroci, Deane, & Anderson, 2002) indicated that assessment of EI by questionnaire did not predict the relationship between performance and emotional function well. The present study adopted the mixed model and assessed EI levels via a questionnaire because the following previous studies showed that EI level assessed by a questionnaire predicted memory performance well.

Toyota (2011a) regarded participants with high EI as individuals who could more effectively process or encode the emotion of an episode associated with a particular target than those with low EI. Participants were asked to recall past episodes associated with each target in the orienting task and then given unexpected free recall tests. The results suggested that participants with high EI equally recalled targets associated with pleasant, neutral and unpleasant episodes; however, participants with low EI recalled targets associated with pleasant and unpleasant episodes more often than they recalled those associated with neutral ones. The results suggested differences in the processing of neutral episodes as retrieval cues by participants with high EI and those with low EI. Banaji and Hardin (1994) suggested that the emotional strength of words determined recall performance involving them. The authors suggested that pleasant and unpleasant episodes were emotionally powerful, and could be effective cues for target retrieval; neutral episodes were emotionally less powerful and less distinctive as effective retrieval cues for targets. However, as participants with high EI could process episodes precisely, even neutral episodes could be emotionally distinctive and serve as effective cues whereas participants with low EI could not process episodes precisely. Namely EI determined the effectiveness of neutral episodes as retrieval cues for target words. Using another type of orienting task, Toyota (2011b) also indicated differences in memory performance between high- and low- EI groups.

However, these studies were not able to find differences in recall performance between pleasant and unpleasant episodes. Baumeister, Bratslavsky, Finkenauer, and Vohs (2001) proposed the focusing notion of "negativity bias," whereby negative emotions/memories are said to be stronger and remembered better than positive ones are (i.e., negative or unpleasant emotions are stronger than are positive or pleasant ones). Further, unpleasant episodes are stronger and more powerful than pleasant ones; specifically, unpleasant episodes elicit stronger emotional encoding than pleasant episodes do. Thus, tar-

gets associated with unpleasant episodes are processed more deeply and strongly than are targets associated with pleasant episodes. According to the encoding variability hypothesis (Martin, 1968; Madigan, 1969; Gartman & Johnson, 1972; Glenberg, 1977; Kitao, 1983), encoding richness determines recall performance during the repeated presentation of targets (Toyota & Kikuchi, 2004, 2005). In terms of emotional encoding, unpleasant episodes elicit stronger encoding than pleasant ones do. The stronger the encoding, the greater the variety that would be produced during repeated presentation, as strong encoding provides more rich or distinctive information than does weaker encoding.

If the above were the case, then the spacing effect would be apparent for targets associated with unpleasant episodes, but not for targets associated with pleasant episodes. However, as Toyota (2011a) indicated, participants with high EI could activate the emotional encoding of targets even if the elicited emotion is weaker, but participants with low EI could not. Considering these individual differences in EI, it is predict that for participants with high EI, the spacing effect should be observed for targets associated with both pleasant and unpleasant episodes. However, for the participants with low EI, the effect should only be found for targets associated with unpleasant episodes.

2. Method

2. 1. *Participants*

A total of 32 volunteers (two men and 30 women), with a mean age of 19.50 years (SD=3.09; range=18.20-32.50). These participants were undergraduates. They each participated voluntarily and were debriefed upon completion.

2. 2. *Measures*

To select high-EI and low-EI groups, the Japanese version of the Emotional Intelligence Skills and Competence Questionnaire (J-ESCQ) was used. The original version of the Emotional Intelligence Skills and Competence Questionnaire (ESCQ) was developed by Takšić (1998) based on the definitions proposed by Salovey and Mayer (1990). The ESCQ has three subscales corresponding to three sub-abilities: the ability to express and label emotion (EL); the ability to perceive and understand emotion (PU); and the ability to manage and regulate emotion (MR). Toyota, Morita, and Takšić (2007) used the ESCQ as the basis for the J-ESCQ. The J-ESCQ consists of 24 items divided into three subscales: (1) PU (Cronbach's alpha=.91, range 8-40, e. g., "I notice when somebody feels down."), (2) EL (Cronbach's alpha=.88, range 8-40, e.g., "I am able to express my emotions well."), and (3) MR (Cronbach's alpha=.65, range 8-40, e.g., "I try to keep up a good mood."). Participants answered on a five-point scale ("never" "seldom" "occasionally" "usually" or "always") how often each of these statements applied to them. Cut-off of mean±1SD of the Total J-ESCQ score was used to select two groups: a high-EI group consisting of one male and 11 female participants and a low-EI group consisting of one male and 10 female participants. The remaining nine participants in the middle range of EI, one male in a high-EI and one male in a low-EI group were removed in the following analysis. The mean age of these female participants was 19.10 years (range: 18.20-20.10). Scores between the high- and low-EI groups were assessed with t-tests using their J-ESCQ EL, PU, and MR scores. These results revealed that the high EI group had a higher EL ($M=26.82$, $SD=3.30$ for high-EI and $M=20.50$,$SD=3.23$ for low-EI; $t\ (19)=4.21$, $p<.001$; Cohen's $d=1.93$), PU ($M=26.45$, $SD=3.92$ for high-EI and $M=22.20$,$SD=3.25$ for low-EI; $t\ (19)=2.56$, $p<.05$; Cohen's $d=1.18$), MR ($M=29.55$, $SD=2.87$ for high-EI and $M=24.60$, $SD= 3. 56$ for low-EI; $t\ (19)=3.35$,$p<.01$;Cohen's $d=1.53$), and total ($M=82.82$, $SD=5.92$ for high-EI and $M=67.30$,$SD=4.78$ for low-EI; $t\ (19)=6.24$, $p<.001$; Cohen's $d=2.88$) scores than the low-EI group had.

2. 3. *Materials*

The target words (were selected from a normative set reported in a previous study (Kitao, Hatta, Ishida, Kondo, & Babazono, 1977). Each target word was written in idiographic Japanese characters (Kanji) familiar to the participants. Concreteness of these word ranges from 81 to 98%. And familiarity ranges from 4.1 to 5.8. Two types of presentation (spaced and massed) were provided.

The targets were listed on 30 PowerPoint slides; seven slides containing target words were assigned to each of the two presentation conditions: spaced or massed. Therefore, 14 slides were presented twice, and two buffer slides were presented for the first and last serial positions of the orienting list. The number of interpolated slides was fixed at five for the spaced presentation, but there were no interpolated slides for the massed presentation.

2. 4. *Procedure*

The experiment was conducted with a group of par-

ticipants under conditions of incidental memory. First, the participants were told that the task was a pilot test to gather information about the Japanese language.

2. 4. 1. *Orienting task.*

The task was explained with examples of slides placed on a screen at the front of a classroom. The orienting instructions were as follows: "A Kanji word is shown on the screen. On each slide like this (pointing to the example on the screen), your task is to recall episodes you have experienced in the past, but not say anything. Then the same words will appear, and you will be free to recall the episode you have already recalled or a different one." Each target assigned to the massed presentation condition appeared on two successive slides of different colors (white and yellow) for the orienting list. In the spaced presentation condition, each target was presented on two slides (white and yellow) separated by five interpolated slides within the list. Each participant performed the tasks on each slide with a time limit of 5 sec. per slide.

2. 4. 2. *Free recall test.*

Following the orienting task, participants were given 5 min. to recall and write down as many of the target words as possible.

2. 4. 3. *Check phase.*

Following the free recall test, participants were provided a sheet that had all the target words printed on it. Each participant was asked to indicate whether each target word reminded him or her of a past episode. If a target elicited an episode, then the participant was asked to circle "Yes"; if not , he/she circled "No" (i.e., no episode elicited). If a particular target word reminded the participant of an episode, then he or she was asked to indicate whether the episode was pleasant or unpleasant by circling either "Good" or "Bad". In the case where the episode recalled at one of the two presentations (e.g., the first presentation) was pleasant and the episode recalled at the other presentation (e.g., the second presentation) was unpleasant, the participants were asked to circle both "Good" and "Bad." This checking phase lasted 5 min.

2. 5. *Design*

A 2 × 2 × 2 design was used with level of EI (high vs. low; between-subjects), type of presentation (spaced vs. massed; within-subjects), and type of episodes (pleasant vs. unpleasant; within-subjects) as the independent variables.

3. Results

When assessing the checking of ep-isodes, the number of pleasant, un-pleasant and "No" episodes differed for each participant. The counting pro-cedure about the number of episodes and number of targets correctly recalled were as follows. For example, if the participants recalled an unpleasant episode at the first presentation, but no episode at the second presentation of a target, the number of episode was assigned as 0.5 episodes into each of the "pleasant episode" and "no episodes" categories. When a target corresponding to such a case was recalled during the free recall test, then the number of correctly recalled targets was assigned as 0.5 in each of the "pleasant episode" and "no episode" categories. Further if a participant re called a pleasant episode at the first presentation and an unpleasant episode at the second presentation of a target, a value of 0.5 episodes was assigned to each of the "pleasant episode" and "unpleasant episode" categories. When a target corresponding to such a case was recalled during the free recall test, the number of correctly recalled targets was assigned as 0.5 for both the "pleasant episode" and "unpleasant episode" categories. The means for all types of episodes (pleasant vs. unpleasant vs. no episode) are shown in the upper part of Table 1. The percentage of target words correctly recalled was calculated on the basis of these numbers. These percentages are shown in the lower part of Table 1 as a function of the type of episodes (pleasant vs. unpleasant vs. no episode) and the type of presentation (spaced vs. massed). However, the percentages corresponding to no episodes were calculated for only a small number of participants, because 3 - 4 participants in both EI groups recalled episodes for all the targets. As the present study focused on the difference in recall percentage between pleasant and unpleasant episodes, the following analysis excluded data that contained no episodes.

A 2 (EI; high- vs. low-EI groups) × 2 (type of presentation) × 2 (type of episode) analysis of variance (ANOVA) was conducted on the percentages of targets words correctly recalled. This ANOVA showed that the interaction between EI and type of presentation ($F(1, 19) = 3.48$, $p < .08$, $\eta 2=.02$) was marginally significant. Planned comparisons were performed for this interaction. Although the simple main effect of type of presentation was not significant for the low-EI group ($F(1, 19) = .22$, ns), this

effect was significant for the high-EI group (F (1, 19) = 4.68, p < .05), indicating that the spaced presentation led to better recall than the massed presentation for the high-EI group. The three-way interaction between EI, type of presentation and type of episode was also marginally significant (F (1, 19) = 3.07, p < .09, η 2= .02). Planned comparisons were also performed for this interaction. Alt-hough the simple interaction between the type of presentation and type of episode was not significant for the high EI group (F (1, 19) = .14, ns), this interaction was significant for the low EI group (F (1, 19) = 4.46, p < .05). For the low EI group, the simple main effect of type of presentation was marginally significant for targets with pleasant episodes (F (1, 38) = 3.53, p < .07), but that simple main effect was not significant for targets with unpleasant episodes (F (1, 38) = 1.55, ns). This indicates that massed presentation led to better recall of targets with pleasant episodes than the spaced presentation, but the difference between the two presentations was not observed for those with unpleasant episodes.

4. Discussion

The purpose of this study was to examine the spacing effect in incidental memory as a function of EI and type of episode. As predicted, for participants with high EI, the spacing effect was observed for targets as-sociated with both pleasant and unpleasant episodes whereas for participants with low EI, the effect was observed for only targets associated with unpleasant episodes. According to the encoding variability hypothesis (Martin, 1968; Madigan, 1969; Gartman & Johnson, 1972; Glenberg, 1977; Kitao, 1983), spaced presentation facilitated encoding variability between the first and second presentations whereas massed presentation did not. In this study, participants were asked to generate an episode and judge whether it was good (pleasant) or bad (unpleasant) as elicited by a target: in other words, participants encoded an emotion for each episode. Spaced presentation facilitated encoding variability for this emotional en-coding between the first and second presentations. However, as individual differences in the level of EI produced differences in the activation of emotional encoding elicited by each target, participants in the low-EI group had difficulty with these activations of the targets associated with pleasant episodes. As mentioned before, according to a review by Baumeister et al. (2001), pleasant episodes engender weaker activation than unpleasant ones generate. As low-EI participants did not activate the emotional encoding of targets associated with pleasant episodes, emotional encoding did not seem to vary across the first and the second target presentations for this group. Therefore, the spacing effect (e.g., the superiority of spaced to massed presentation) disappeared. On the other hand, high-EI participants activated the emotional encoding of targets even when they elicited weaker emotions (e.g., pleasantness). This activation facilitated encoding variability across repeated presen-tations, leading to the spacing effect for both types of episodes.

In the present study, EI was regarded as index of

Table 1 Mean Number of Episodes and Percentages of Targets Recalled Correctly in Free Recall Test

Type of episode		Pleasant episode		Unpleasant episode		No episode	
Type of presentation		Massed	Spaced	Massed	Spaced	Massed	Spaced
Numbers of episodes							
High EI	*M*	3.45	3.64	2.09	2.73	1.45	0.64
	SD	1.14	0.98	0.82	0.96	1.37	0.48
Low EI	*M*	3.05	3.90	2.35	2.00	1.60	1.10
	SD	0.96	1.04	0.71	0.77	1.28	1.22
Recall of targets							
High EI	*M*	.40	.61	.45	.59	.29	.14
	SD	.36	.29	.38	.35	.36	.35
						n=7	n=7
Low EI	*M*	.68	.46	.38	.53	.07	.04
	SD	.33	.35	.32	.41	.15	.09
						n=7	n=6

emotional encoding: namely, richer encoding is associated with higher levels of EI. However, EI has three aspects; EL, PU and MR. The specific aspect(s) of EI that contributed to memory performance were not definitively identified in the present study. Both EL and PU have a common element that facilitates emotional encoding. However, MR does not facilitate emotional encoding (and in some cases suppresses) emotional encoding. Previous studies (Richards & Gross, 2000, 2006) have indicated that participants with high rates of expressive suppression (which is one form of emotional regulation) do not perform well on memory tasks. Those results, along with those of the present study, suggest that EL and PU might be positive predictors of memory: however, MR might be a negative predictor, which might prevent the activation of emotional encoding upon exposure to each target. Further research is necessary to determine which aspect of EI contributes most to memory performance.

While not a main interest of the current study, the present results indicated a negative spacing effect (the advantage of the massed presentation over the spaced presentation) for targets with pleasant episodes but only in the low EI group. Repeated encoding leads to a strong association between each target and the encoding of that target, especially in the massed presentation condition. Kitao (1983, 2002) stressed the importance of the association between a target and its encoding. This difference in the strength of association between a target and its emotional encoding might have been the determining factor in the observed differences. The low- EI participants encoded targets with pleasant episodes by adding similar emotions across the massed presentation. In this case, the association between each target and its encoding would be strong. However, as high-EI participants have high levels of emotional encoding, the variability of emotional encoding is also high. If so, high-EI participants should encode the targets associated with pleasant episodes by adding dissimilar emotions across the repeated massed presentation.

Finally the limitations of the present study should be mentioned. Specifically the participants were all female. Although the gender difference could not be predicted, further research will be necessary to control for gender. As mentioned above, the present study did not focus on each aspect of EI: EL, PU and MR. Further researches were necessary to clarify which aspect of EI was most critical to the spacing effects caused by emotional encodings as well as memory performance.

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【日本語要旨】

偶発記憶における分散効果と情動知能の個人差

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本研究は，情動知能（EI）の高い参加者と低い参加者における偶発記憶の分散効果の違いを検討した。大学生32名に対して，情動知能尺度（J-ESCQ, Toyota *et al.*, 2007）を実施し，尺度の総得点が高い参加者（EI高群）と低い参加者（EI低群）を12名ずつ抽出した。これらの実験参加者に対して，集団実験が実施された。方向づけ課題では，パワーポイントで作成されたスライドが提示され、提示される記銘語には、北尾ら（1977）から選択された語であり、１字で意味を持つ漢字であった。各語は２回提示されたが，連続提示される集中提示条件と、他の語をはさんで提示される分散提示条件が設けられた。参加者は提示された単語から過去のエピソードが想起できるがどうかを考えるように求められた。この方向づけ課題直後に、偶発自由再生テストが実施され，提示された単語の書記再生が求められた。その後、記銘語を印刷した用紙が配布され、各記銘語から想起した過去のエピソードが快か不快かを判断するように求められた。参加者の想起したエピソードに基づいて、再生率を分析した結果、EI高群では想起したエピソードが快でも不快でも、分散提示条件が集中提示条件よりも再生率が高いという分散効果が見いだされた。一方、EI低群では想起されたエピソードが不快な場合には分散効果が出現したが、快なエピソードが想起された場合には、分散効果は消失した。この結果は、Baumeister *et al.*（2001）による不快情動が快情動よりも強いという主張によって解釈された。すなわち、EI低群は強い情動である不快感情を喚起する場合には、その情動をうまく活性化できるが、弱い情動である快の場合にはこの活性化ができず、情動を記銘語の検索手がかりとして利用できないのである。一方、EI高群は、情動処理能力が高いので、快でも不快でもその情動の強さにかかわらず、検索手がかりとして利用できたのである。