Effects of Experience of Listening to Short Sentences Containing ANEWs on Memory: An Analysis Based on Pupillary Responses during Listening and Visual Behavior during Impression Evaluation

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a short resume of the presenter

- Katsuko T. Nakahira is an
  associate professor at Nagaoka University of Technology
  - received the
    Master of Education at Nara University of Education
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  - Her research interests lies in the intersection of
    perceptual informatics, cognitive architecture, human interface,
    educational technology, service informatics……

Research Background

our final objective

designing multimodal content that can be easily recalled
by real-time detection of such emotional responses

- related knowledge
  - relation between pupillary response, eye movement, and emotion :
    have the potential to detect the occurrence of emotion in response
    to emotional stimuli input to humans

Introduction : findings from previous works

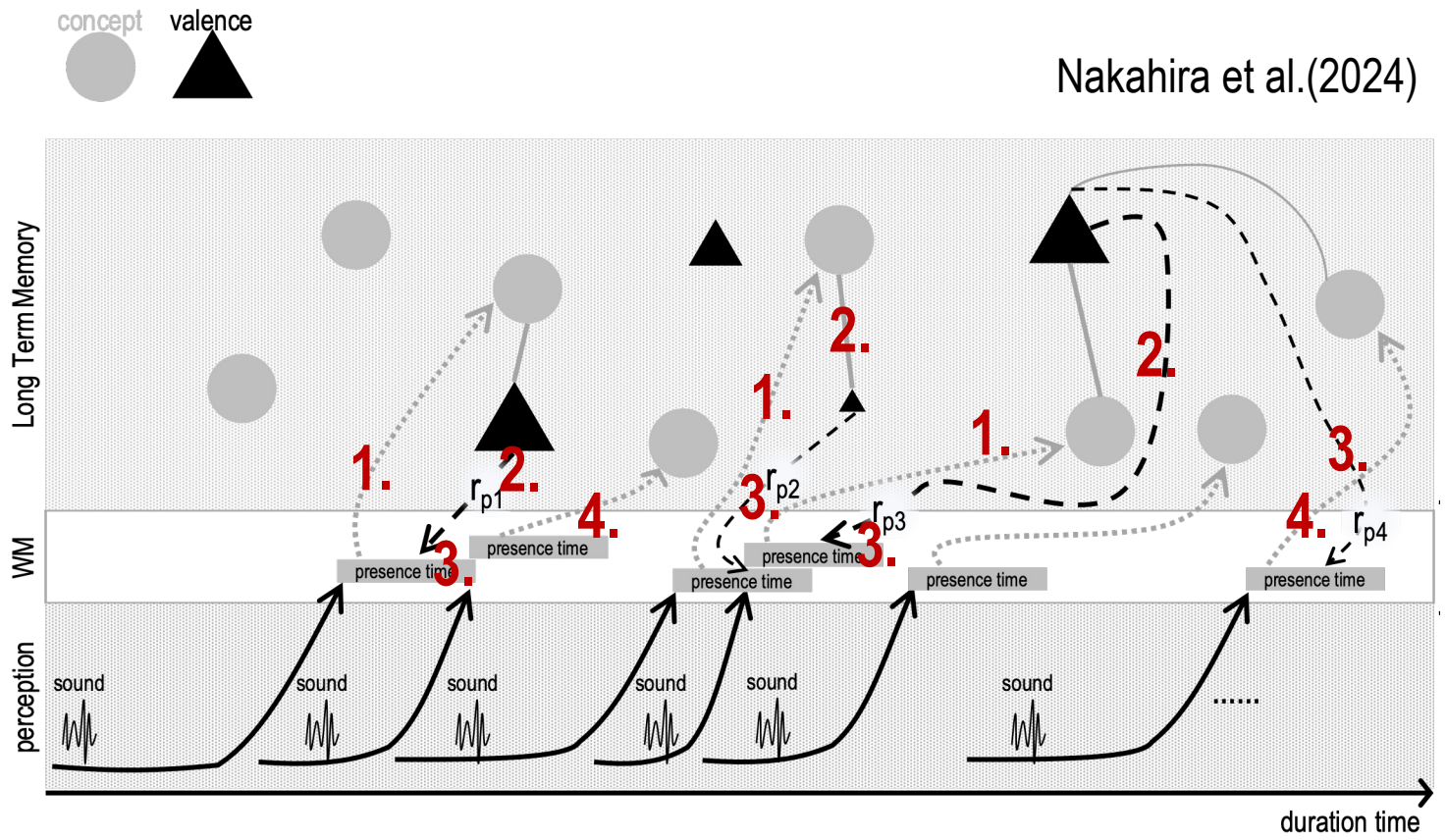
I. possible to optimize the load of perception information processing by adjusting the interval between perception information
II. The degree of emotion generated by Affective Norms for English Words (ANEW) may suppress the characteristics of the total change in pupillary response.
III. constructed a cognitive model of the process of sequential input of externally provided auditory information, its retention in working memory, its recognition, and its updating in the memory network.

- **one of the remaining challenges:**
  - the relationship between
    - the impression evaluation of the presented stimulus
    - the total change in pupillary response
    - the recall rate after listening to the presented stimulus

objective of this article

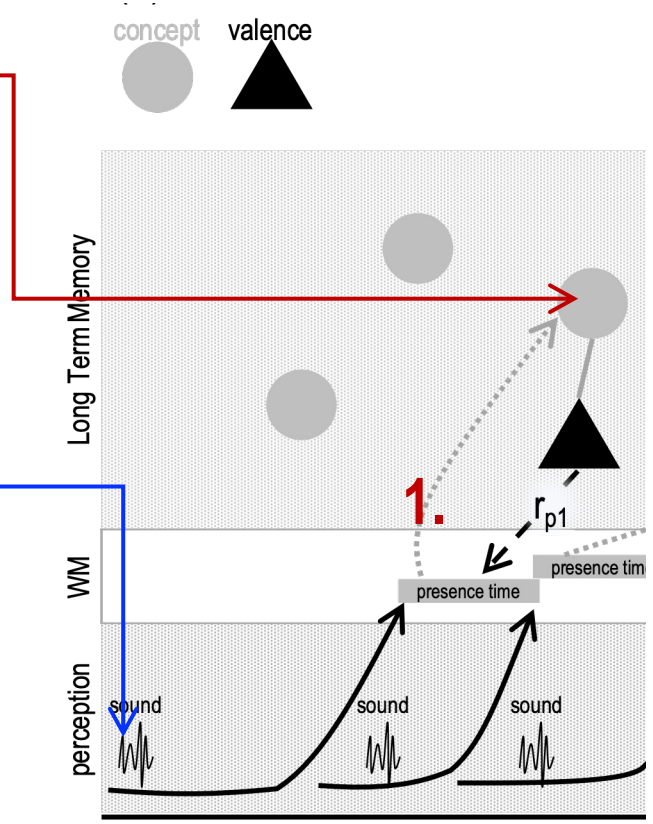
- To estimate these relationship,
  - analyze : the relationship among eye movement data, total change in pupillary response, and recall rate at the time of selecting rating items regarding the impression of listening experience
  - data : based on pupillary response data during short sentence listening and experiences with multiple positive and negative two-level valence

valence evaluation process



valence evaluation process

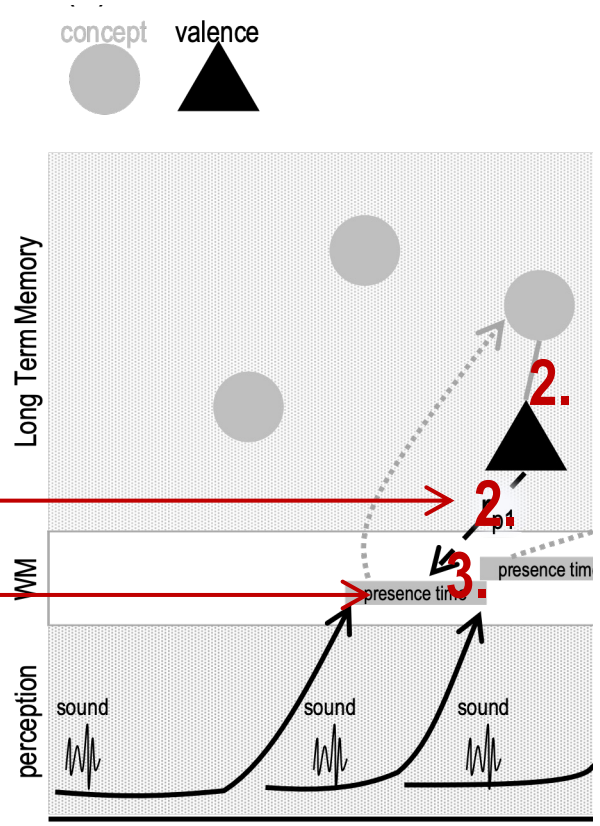
1. the presented auditory information is matched with long-term memory for each specific packet of sound waves, which are basically groups of phonemes that correspond to specific concepts



valence evaluation process

2. The matching results are returned together with the valence and other information associated with the concept.

3. The returned matching results stay in working memory as a group for a certain period of time

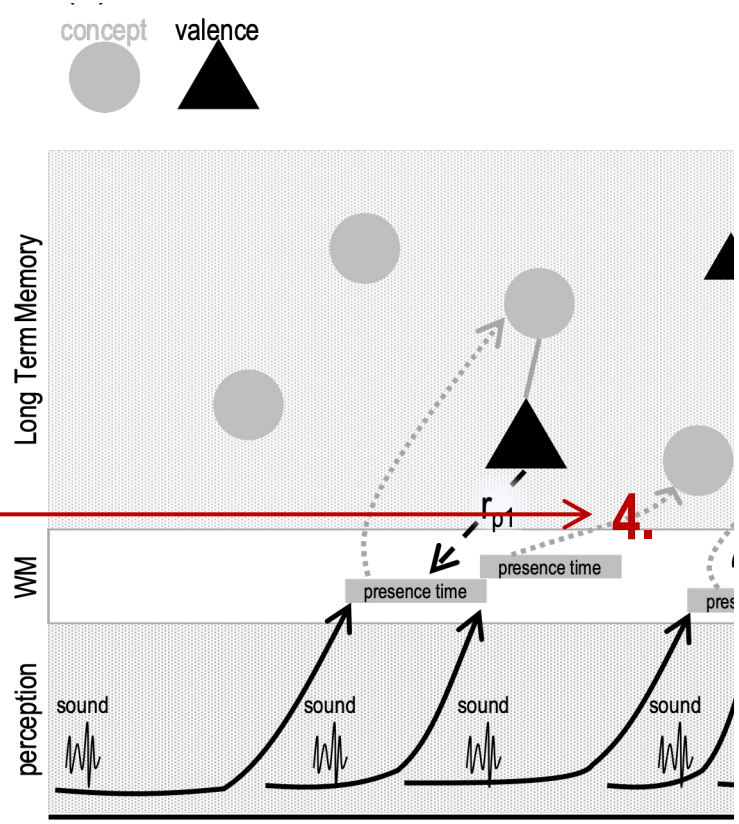


The more the concepts overlap in working memory,
the stronger the connection between the concepts becomes.

valence evaluation process

4. A series of concepts are returned to long-term memory as related

various node relationships, such as between concepts and between concepts and valences, are strengthened



possible biometric measurements

- impression evaluation speed
  - is affected by the clarify of the impression of the listening sentence
  - the time taken by subject p to evaluate the impression of the presented stimulus i is measured and is denoted as t^i_p
- visual behavior during impression evaluation
  - during the viewing of options as an element related to the decision-making process of selecting options
  - n^i_p : number of fixation points
    - regarded as the number of times the subject searches for alternative
  - $t^{i,j}_{f,p}$: the jth fixation time
    - approximate degree to which the user has thought about the choices

design indices

- total fixation time during valence evaluation
  - to confirm the degree to which the subject concentrated on checking the options during t^i_p

$$t^i_{f,p} = \sum_j^{n^i_f} t^{i,j}_{f,p}$$

- t^i_p – $t^i_{f,p}$ ratio
  - to distinguish between cases where the impression evaluation takes a relatively long time and those where it takes time only under certain conditions

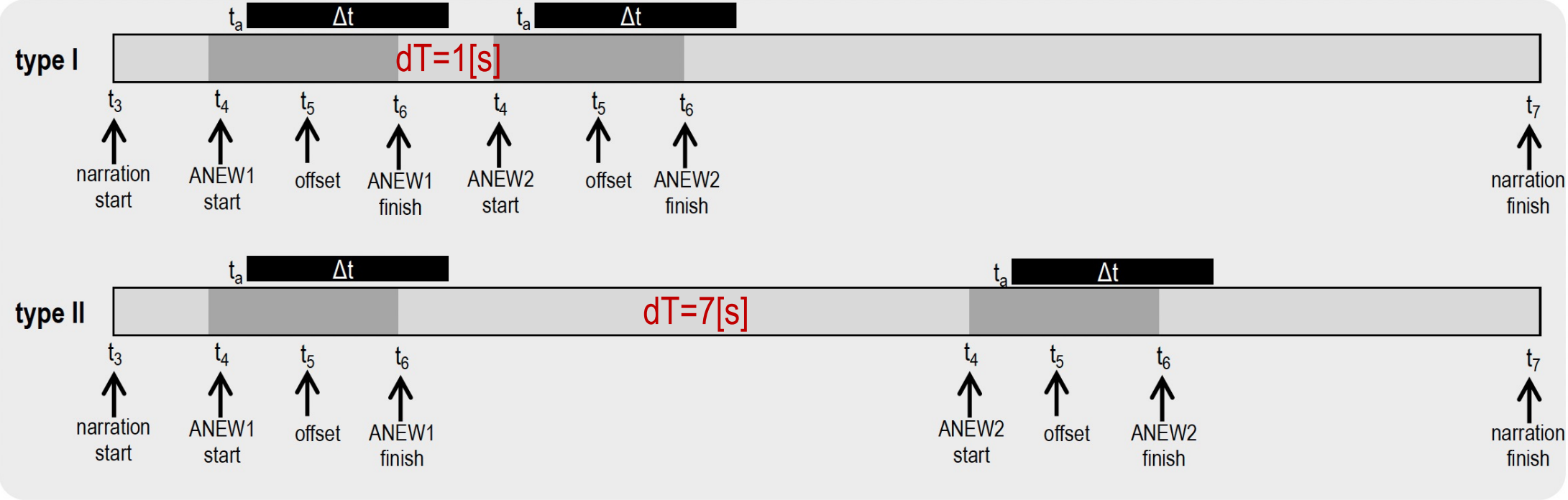
$$T^i_{c,p} = \frac{t^i_{f,p}}{t^i_p}$$

preliminary condition

TABLE I. PARAMETERS PREPARED IN THIS PAPER.

valence pair	dT	
	1 sec	7 sec
(V_{++}, V_{++})	4	4
(V_{--}, V_{--})	4	4
(V_{++}, V_{--})	4	4
(V_{--}, V_{++})	4	4

V_{++} : positive
V_{--} : negative
participants:17



results

relation between measurements for each correct/incorrect answer in the recall

memory availability	valence pair	measurements			ρ	$p-value$
entire set	$(V_{++},\ V_{--}, dT=1)$	r^2_{all}	and	n_f	0.313	0.009
	$(V_{++},\ V_{++},\ dT=1)$	$r^1_{all}-r^e_{all}$	and	$T^i_{c,p}$	-0.240	0.049
	$(V_{++},\ V_{++},\ dT=7)$	r^1_{all}	and	n_f	0.303	0.012
		r^2_{all}	and		0.258	0.034
recalled	$(V_{++},\ V_{--}, dT=1)$	r^2_{all}	and	$t^i_{f,p}$	0.477	0.026
			and	n_f	0.534	0.011
	$(V_{--},\ V_{++},\ dT=7)$	$r^1_{all}-r^e_{all}$	and	$t^i_{f,p}$	0.564	0.008
			and	$T^i_{c,p}$	0.543	0.011

if the dT is

-- short enough to cause interference in emotion induction :

the emotions induced by the multiple ANEWs may interfere with each other

final emotion that remains in the listener's mind may induce more emotions than the original ANEWs induced, or it may repel the original ANEWs and not induce any emotions at all

-- long enough to cause interference in the emotion induction :

will induce only very weak interference

discussion : two trends triggering recall

- the degree of cognitive load due to emotion induction is low, but the stimulus is very impressive, which promotes recall
  - regards as System I
  - time of recall is correlated with r^2_{all} and $t^i_{f,p}$, $n^i_{p,f}$
  - the answers were generally based on the second ANEW impression
- promotion of recall due to a high degree of cognitive load induced by emotion induction
  - regards as System II
  - short $T^i_{c,p}$ and $t^i_{f,p}$: the second ANEW impression was recalled independently, with the difference from the emotional induction being high

conclusion and future works

analyzed the relationship among eye movement data, total change in pupillary response, and recall rate at the time of selecting rating items regarding the impression of listening experience

- responses with a high recall rate were related…..
  - low cognitive load due to emotion induction
  - was associated with a high degree of cognitive load by emotion induction
- for future :
  - the development of a metric to discriminate between the two status of recall will be valuable for designing content that is easier to recall according to the individual

Thank you for your attention!

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