PSI 428
Attentional Processes

Central Processing Limitations in Sensorimotor Tasks

Learning Objectives

- Attention, memory and action
- Theories of central attentional limitations
- Psychological Refractory Period
- The central bottleneck
- Strategies for testing central bottleneck theories

Attention Memory and Action

- We have studied attentional limitations in perception of stimuli
- Attentional limitations in selection of a stimuli
  - Selective attention
  - Divided attention
  - Attentional set

Attention Memory and Action

- We will focus attentional limitations in higher cognitive processes
  - Attentional limitations observed when people try to perform two or more tasks
  - Attentional limitations in learning and memory

Learning Objectives

- Attention, memory and action
- **Theories of central attentional limitations**
- Continuous dual-task performance
- Psychological Refractory Period
- The central bottleneck
- Strategies for testing central bottleneck theories

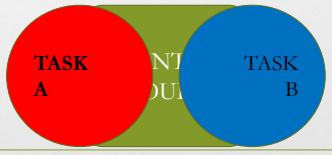
Theories of Central Attentional Limitations in Sensory-Motor Tasks

- Dual-task interference:
- When people do two things at the same time, sometimes interference might arise
- Performance on task A and/or task B is impaired when they are conducted at the same time, compared to when they are conducted separately

Dual Task Interference

Capacity Theories

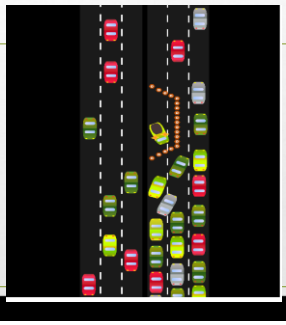
- Dual-task interference could be understood in terms of graded sharing of a single pool of mental sources



Capacity Theories

- Key ideas of capacity theories
  - Two tasks operate in parallel
  - The efficiency is dependent on the amount of resources allocated to the tasks
  - The person can usually vary the allocation at will

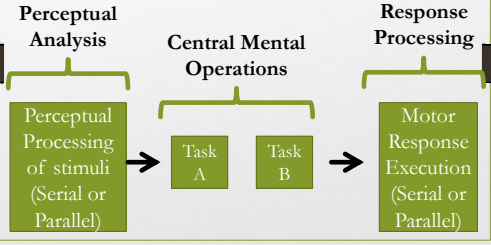
Bottleneck Theories



Bottleneck Theories

- Central mental operations are carried in parallel
- There is a discrete processing bottle neck
- Processing is queued at some stage of information processing
  - at the memory retrieval, decision, response selection, response initiation, or response execution stage

Bottleneck Theories



Learning Objectives

- Attention, memory and action
- Theories of central attentional limitations
- **Psychological Refractory Period**
- The central bottleneck
- Strategies for testing central bottleneck theories

Psychological Refractory Period

- To understand dual-task interference at a mechanistic level more fine-grained analysis is necessary
  - People perform two tasks periodically (not simultaneously)
  - Time to perform each task is measured

Psychological Refractory Period

- Telford, C. W. (1931). The refractory phase of voluntary and associative responses. *Journal of Experimental Psychology*, *14*(1), 1.
- Vince, Margaret A. "RAPID RESPONSE SEQUENCES AND THE PSYCHOLOGICAL REFRACTORY PERIOD1." *British Journal of Psychology. General Section* 40, no. 1 (1949): 23-40.

Psychological Refractory Period

- Each participant carry out two tasks. Each require making a speeded response
  - Task A requires R1 to S1
  - Task B requires R2 to S2
- The SOA (Stimulus Onset Asynchrony) between S1 and S2 was manipulated
- R2 slows down as the temporal gap between S1 and S2 was decreased

Psychological Refractory Period

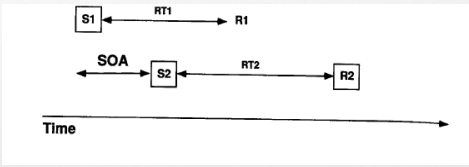
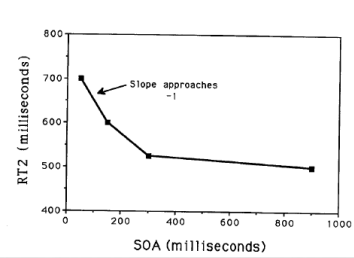


Figure 6.2 of Pashler, H. E. (1998). *The psychology of attention.* Cambridge, MA: MIT press.

Psychological Refractory Period

Figure 6.2 of Pashler, H. E. (1998). *The psychology of attention.* Cambridge, MA: MIT press.

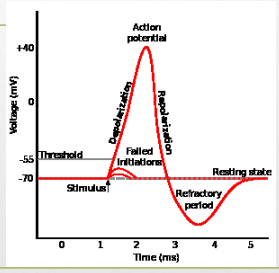


Psychological Refractory Period

- Psychological refractory period was observed with simple RT and choice RT tasks
  - with same finger, different finger, same hand, different hands
  - with manual and eye movements responses
  - vocal and foot responses
  - with auditory, visual and tactile stimuli
  - With S1 and S2 in same or different modalities

Refractory Period in Physiology

- An organ or cell is incapable of repeating a particular action



Psychological Refractory Period

- Telford (1931)
  - "Since refractory phase is regarded as a universal post-stimulation phenomenon of sensitive tissues, the question arises whether a similar effect may be observed which is characteristic of voluntary and associative responses."
  - The effect originates from S-R translation or response selection

Alternative Explanations

- Psychological refractory period (PRP) is observed because of the presentation of S2 is unpredictable
  - PRP was observed even when SOA was held constant across a block

Alternative Explanations

- PRP is observed because people's ability to **keep two tasks prepared** at the same time is limited, rather than to **carry out two tasks** at the same time

Figure 6.3 of Pashler, H. E. (1998). *The psychology of attention.* Cambridge, MA: MIT press.

Alternative Explanations

- The dual task execution was slower compared to the dual task preparation

Type of Block	Tone Task	Color Task
Tone Task alone	605 msec	---
Color Task alone	---	538 msec
Tone or Color Task	732 msec	599 msec
Tone and Color Task	847 msec	728 msec

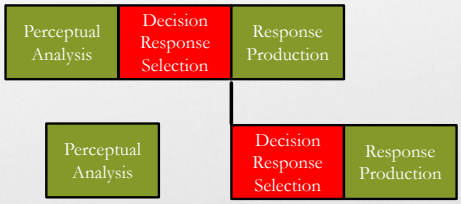
Figure 6.3 of Pashler, H. E. (1998). *The psychology of attention.* Cambridge, MA: MIT press.

Figure 6.3

Learning Objectives

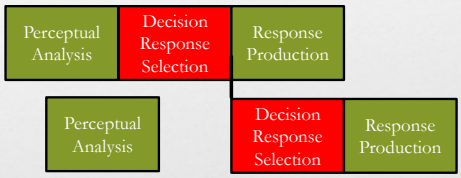
- Attention, memory and action
- Theories of central attentional limitations
- Psychological Refractory Period
- **The central bottleneck**
- Strategies for testing central bottleneck theories

Central Bottleneck



Central Bottleneck

- Does this theory assume serial or parallel processing?



Van Galen, G. P., & Ten Hoopen, G. (1976). Speech control and single channelness. *Acta Psychologica*, *40*(3), 245-255.

Van Galen & Hoopen (1976).

- **Method:**
- **S1**: P A E
- **R1**: As soon as possible, pronounce 'periodiek' after P, 'magistraal' after M, no response after the letter E (catch trial)
- **S2** A B E
- **R2** As soon as possible, push a button after A or B but not after E (catch trial)

Van Galen & Hoopen (1976) Method

The three possibilities of S_2 arrival are depicted in fig. 1.

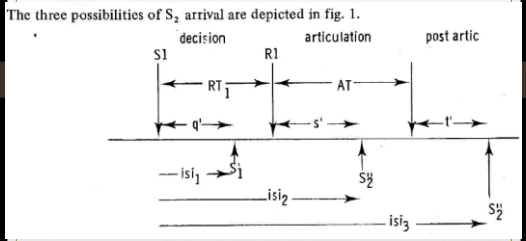
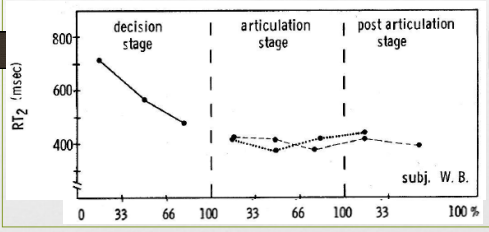


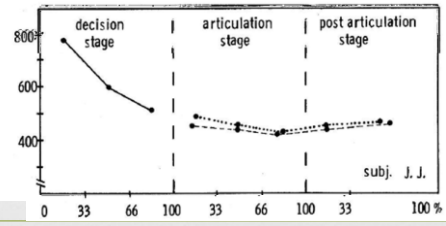
Table 1
Subdivision of the trial sets q, s and t into percentile classes, which, for reference purposes, are called data classes A through H.

Trial set	Percentile class	Data class	Remarks on S_2 arrival during stages
q	$0 \leqslant q < 33\%$	A	early in decision
	$33 \leqslant q < 66\%$	B	midway in decision
	$66 \leqslant q < 100\%$	C	late in decision
s	$0 \leqslant s < 33\%$	D	early in articulation
	$33 \leqslant s < 66\%$	E	midway in articulation
	$66 \leqslant s < 100\%$	F	late in articulation
t	$0 \leqslant t < 33\%$	G	early in post-articulation
	$33 \leqslant t \leqslant 100\%$	H	late in post-articulation

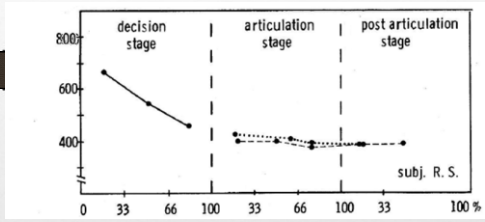
Van Galen & Hoopen (1976) Results



Van Galen & Hoopen (1976) Results



Van Galen & Hoopen (1976) Results



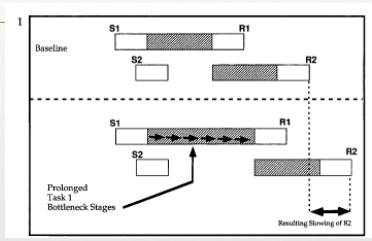
Van Galen & Hoopen (1976) Conclusion

- RTs were unaffected when S2 arrived during the articulation, but RTs were substantially elevated before the articulation (during the decision)
- Psychological refractory period is related with decision / S-R translation / response selection processes

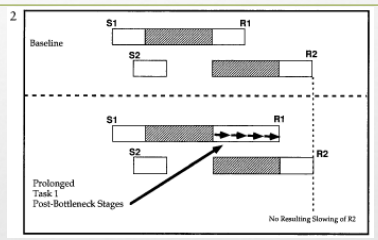
Learning Objectives

- Attention, memory and action
- Theories of central attentional limitations
- Psychological Refractory Period
- The central bottleneck
- **Strategies for testing central bottleneck theories**

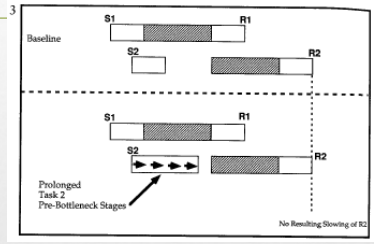
Strategy 1



Strategy 2



Strategy 3



Strategy 4