

# Object Localization under Uni- and Multi-Tasking Conditions

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# How do we recognize different spatial configurations?

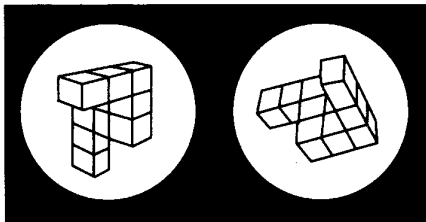


# How do we recognize spatial configurations from different points of view?

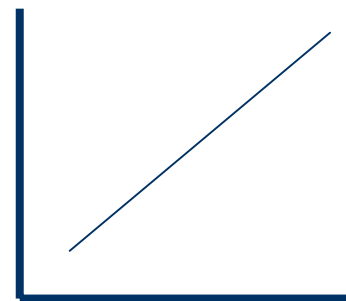


# Mental rotation

- **Object rotation** (Cooper, 1975; Cooper & Shepard, 1973; Shepard & Metzler, 1971; Tarr & Pinker, 1989, 1990)



Time



0 90 180

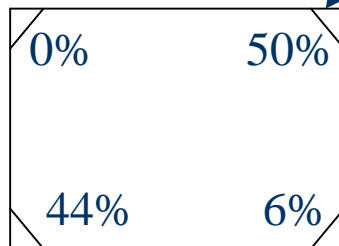
- **Array rotation** (Diwadkar & Mc Namara, 1997; Huttenlocher & Presson, 1973, 1979; Presson, 1982; Shelton & McNamara, 1997; Wang & Simmons, 1999; Wraga, Creem & Proffitt, 2000)

- Mentally rotate one of the scenes and check whether it aligns with the other scene

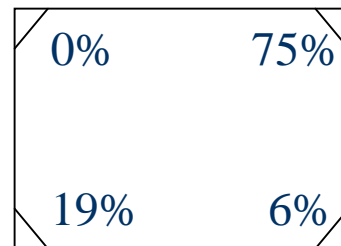
# Covert verbal descriptions

- Compare verbal encodings of the two scenes  
(Bethell-Fox & Shepard, 1988; Hermer-Vazquez, Spelke & Katsnelson, 1999; Simons, 1996; see also Carlson, 2000; Hayward & Tarr, 1995)
- Hermer-Vazquez, Spelke & Katsnelson (1999)

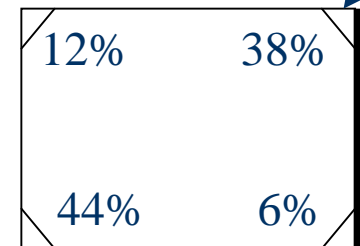
(a) No shadowing w/  
four white walls



(b) No shadowing w/  
one dark wall



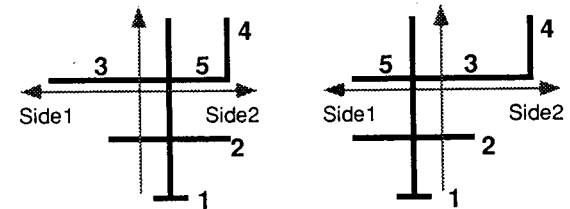
(c) Verbal shadowing w/  
one dark wall



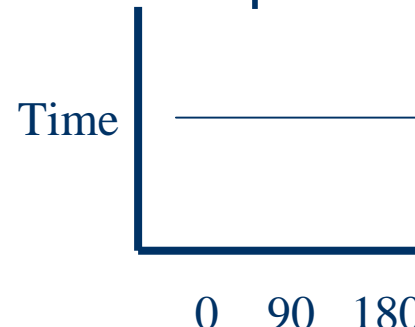
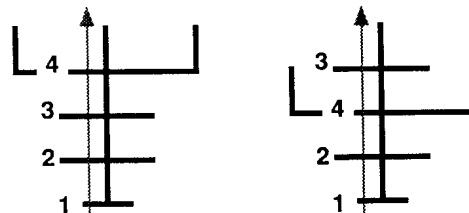
- Language allows us to conjoin geometric and non-geometric information

# Verbal descriptions and RT

- Tarr & Pinker (1990)
  - Mental rotation: used when discrimination requires **two-dimensional** descriptions

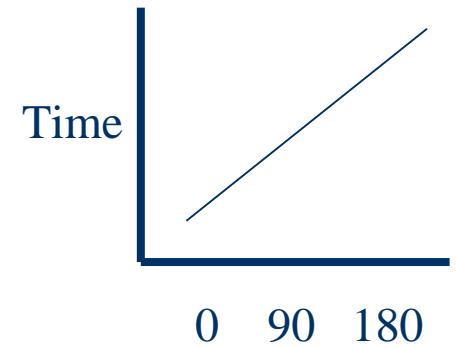


- Orientation-invariant recognition: discrimination requires only **one-dimensional** descriptions

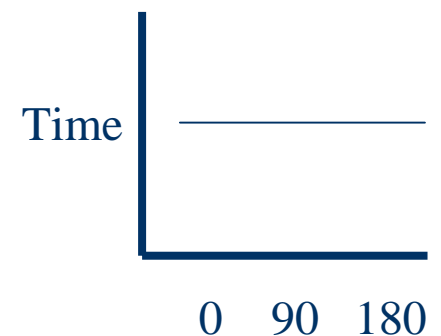


# Testing for use of mental rotation and verbal descriptions

- Non-intrinsic sides  $\Rightarrow$  LOW verbal discriminability



- Intrinsic sides  $\Rightarrow$  HIGH verbal discriminability



# Experiment 1

- Participants. 40 undergraduates
- Materials.
  - 384 pairs of scenes
  - 1 figure object (woman) & 24 reference objects
  - Woman's position (front vs. back) x  
Sides (intrinsic vs. non-intrinsic)
  - Each scene rendered (computer-drawn) from 8  
different perspectives

# Materials (continued)

0°



45°



90°



135°



180°



# Procedure

Screen 1 (1 s):

\*

Screen 2 (time to press  
arrow key):

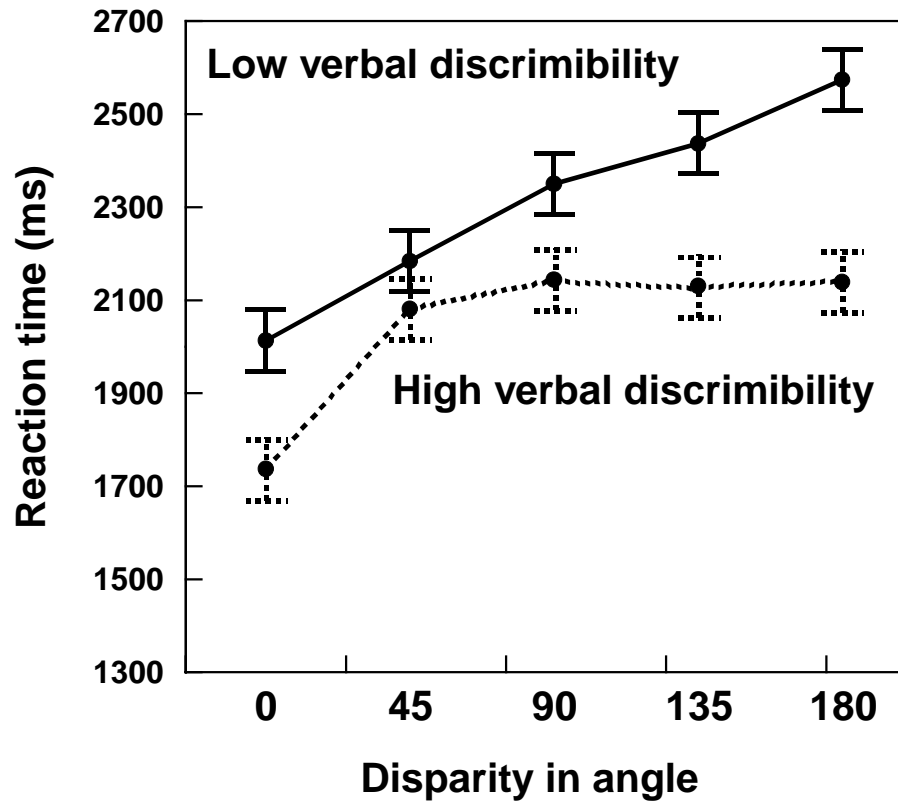
Left → same

Right → different



Screen 3 (1 s):

# Results E1



RTs for matches only



# Verbal discriminability

- High verbal discriminability

Match



Mismatch(es)

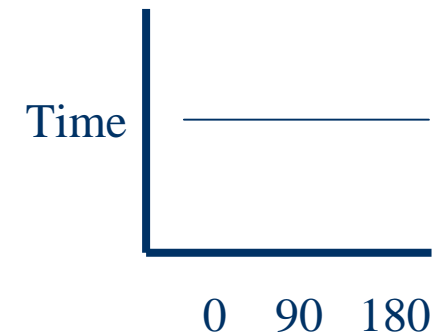


- Low verbal discriminability

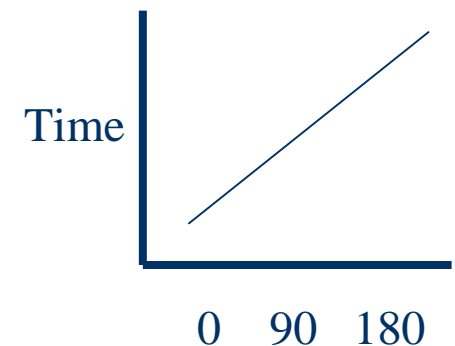


# Testing for use of mental rotation and verbal descriptions

- One kind of mismatch  $\Rightarrow$  HIGH verbal discriminability



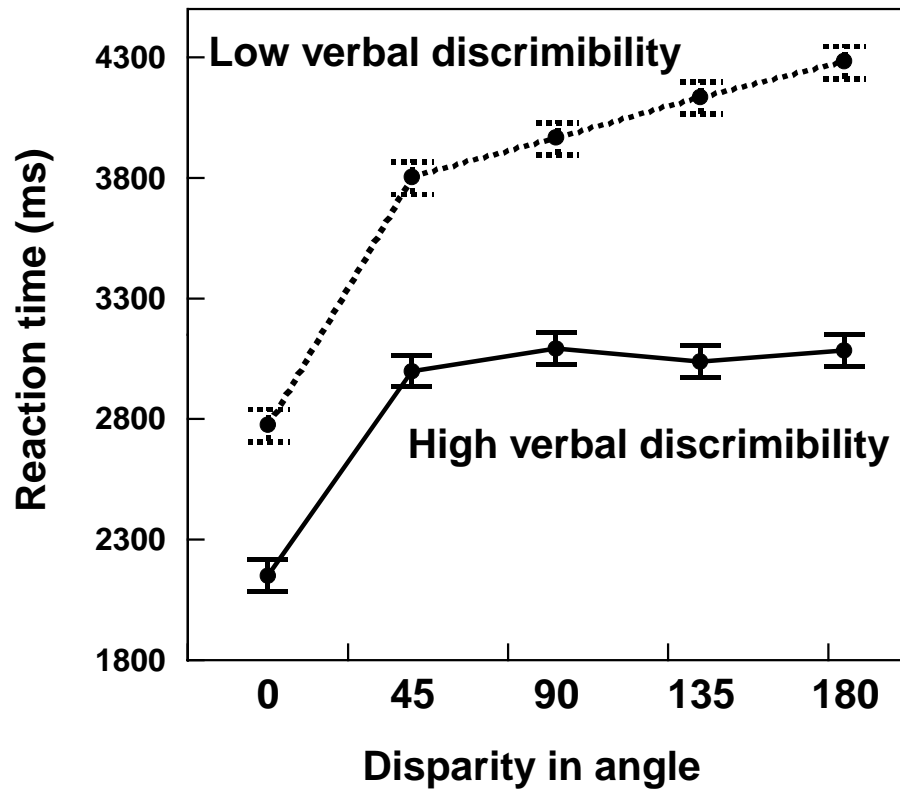
- Two kinds of mismatches  $\Rightarrow$  LOW verbal discriminability



# Experiment 2

- Participants. 64 undergraduates
- Materials.
  - All reference objects (n=12) have intrinsic sides
  - Two kinds of mismatches
    - Woman's position (front vs. back) x
    - Woman's facing direction (left vs. right)
  - Each scene rendered (computer-drawn) from 8 different perspectives
- Procedure. Same as in E1

# Results E2



RTs for matches only



# How a secondary task might affect processing

Strategy	Assigned 1st task strategy	Chosen 2nd task strategy
Different	Spatial	Verbal
	Verbal	Spatial
Same	Spatial	Spatial
	Verbal	Verbal

- Avoid process-interference
- Avoid process-switching

# Experiment 3

- Participants. 128 undergraduates
- Materials.
  - All reference objects have intrinsic sides
  - Low verbal discriminability scenes  
(two kinds of mismatches)
- Procedure
  - Memorize a set of letters (verbal) or positions (spatial)
  - Match two configurations
  - Recognize the letters or positions shown earlier

# Verbal task

(Logie, Zucco, & Baddeley, 1990)

Screens 1-4 (1.5s):

\*

D

N

W

P

Screen 5 (time to press  
arrow key):



Screen 6-9 (1.5s):

D

N

W

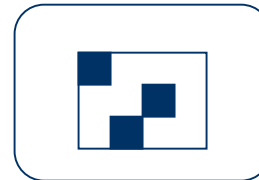
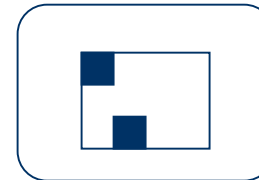
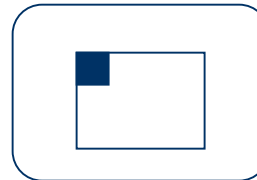
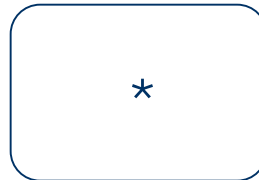
K



# Spatial task

(Logie, Zucco, & Baddeley, 1990)

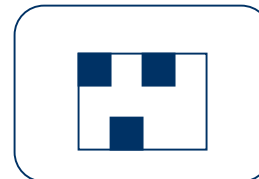
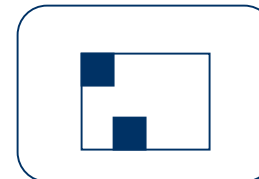
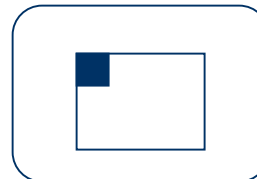
Screens 1-4:



Screen 5 (time to press  
arrow key):



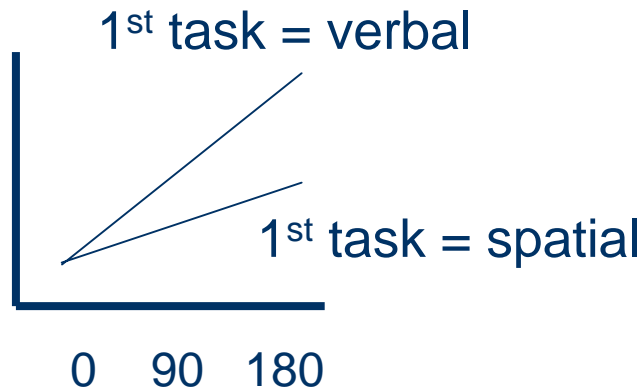
Screen 6-9:



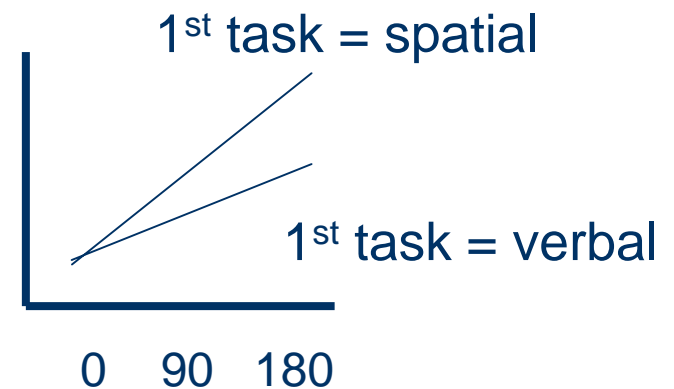
# Predictions

- How performance on **2<sup>nd</sup> task** (matching configurations) is affected by **1<sup>st</sup> task** (verbal or spatial)

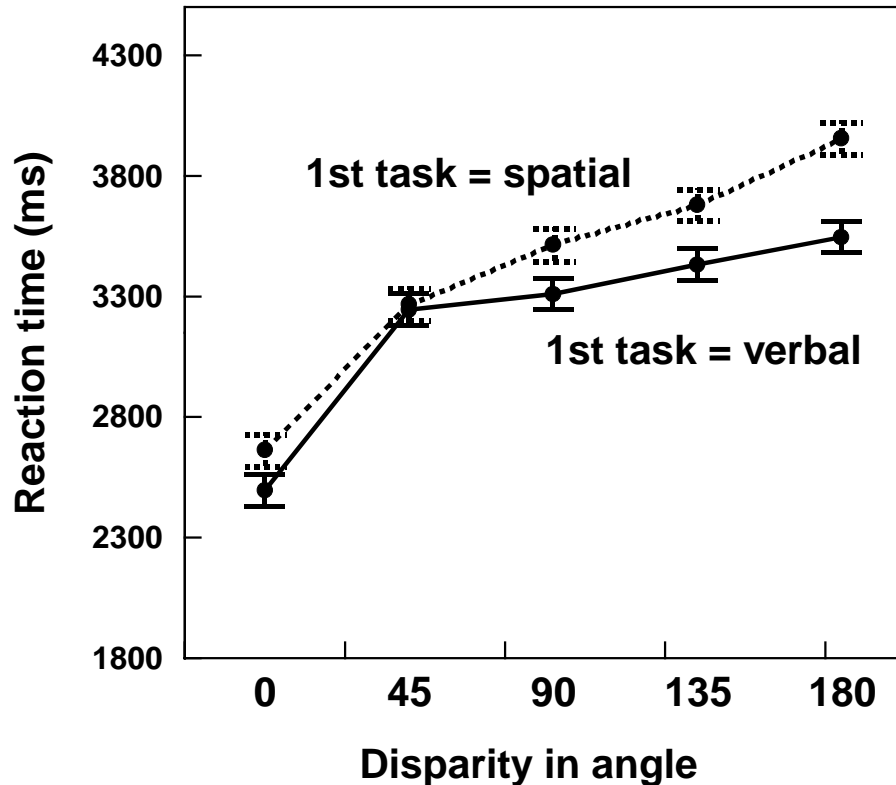
Avoid process-interference



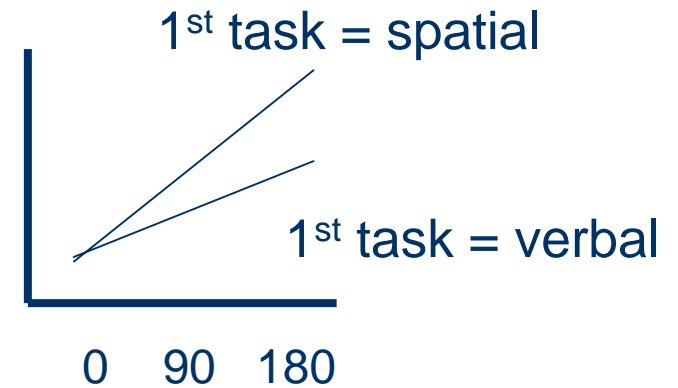
Avoid process-switching



# Results E3



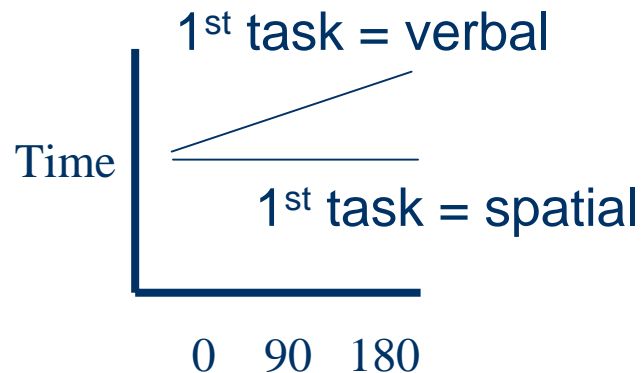
Avoid process-switching



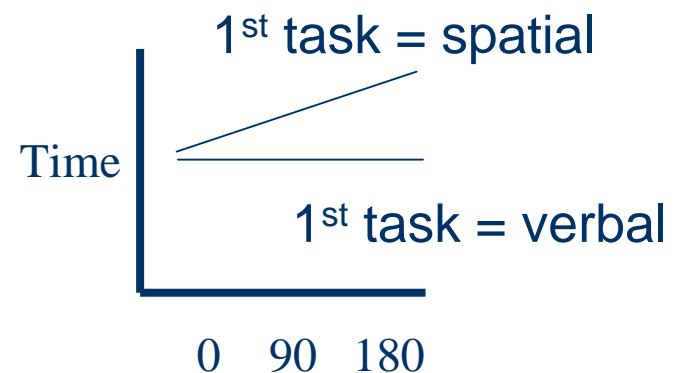
# High verbal discriminability Predictions

- How performance on **2<sup>nd</sup> task** (matching configurations) is affected by **1<sup>st</sup> task** (verbal or spatial)

Avoid process-interference



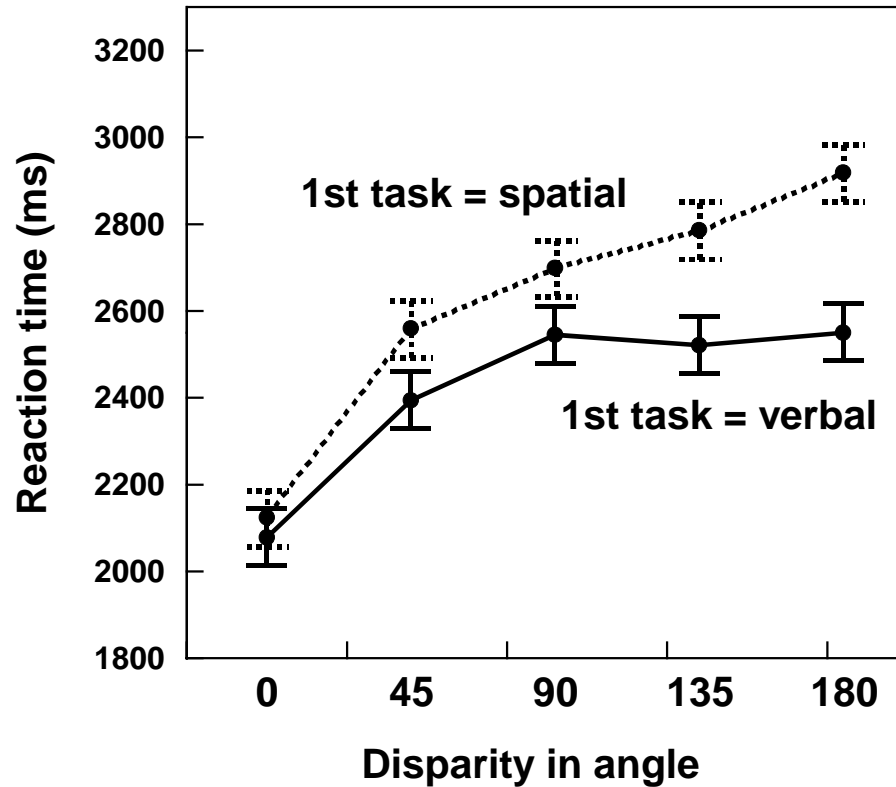
Avoid process-switching



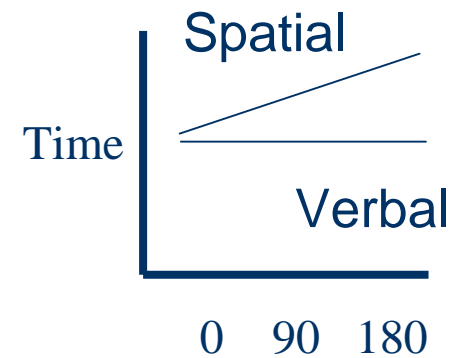
# Experiment 4

- Participants. 128 undergraduates
- Materials.
  - All reference objects have intrinsic sides
  - High verbal discriminability scenes  
(one kind of mismatch)
- Procedure
  - Memorize a set of letters (verbal) or positions (spatial)
  - Match two configurations
  - Recognize the letters or positions shown earlier

# Results E4

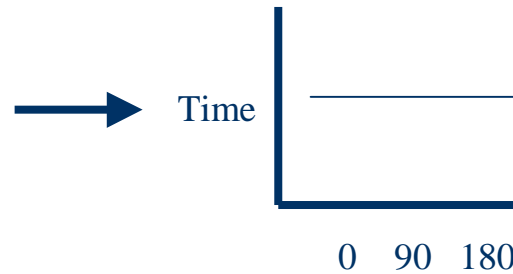


Avoid process-switching



# Predictions when tasks are performed simultaneously

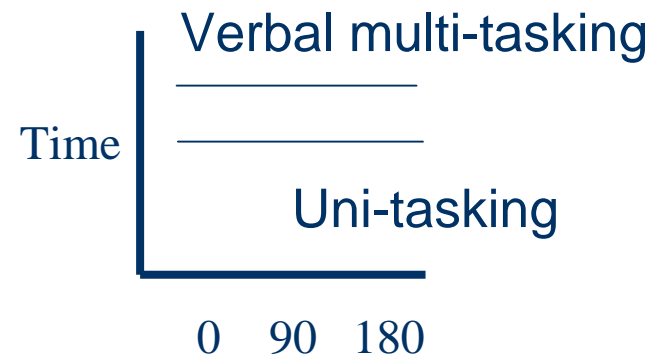
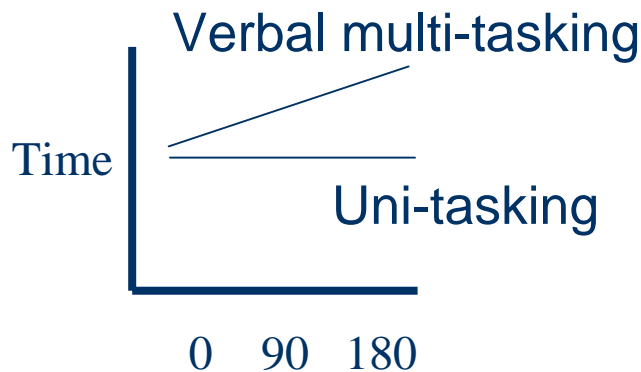
- Uni-tasking condition



- Multi-tasking condition (verbal shadowing)

Avoid process-interference

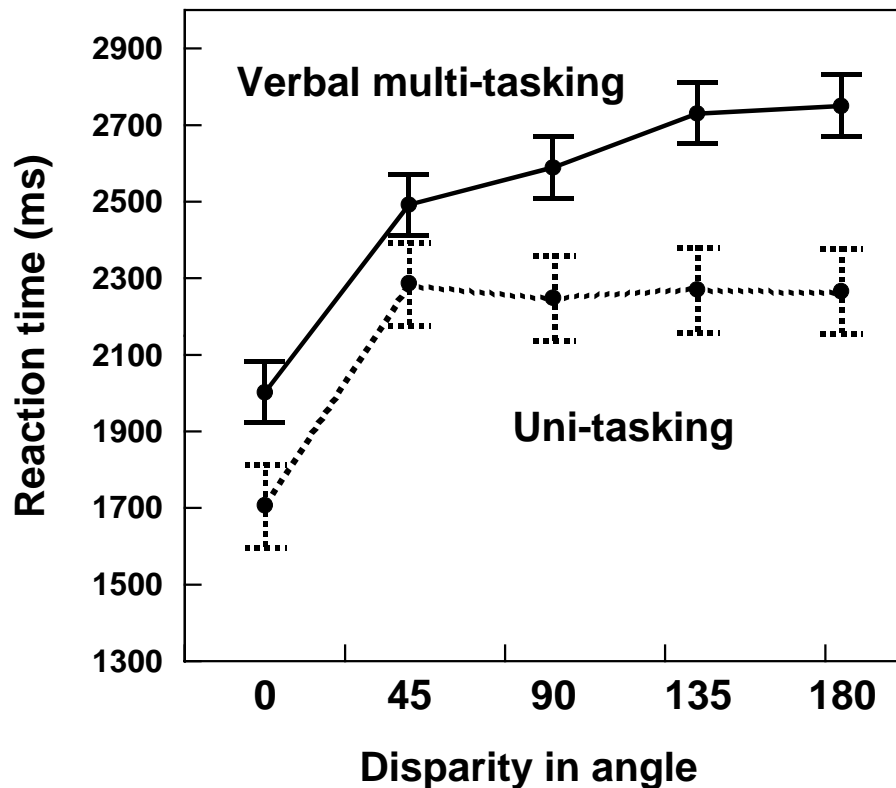
Avoid process-switching



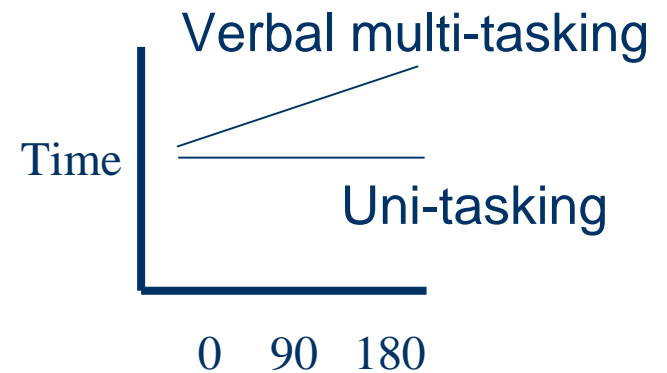
# Experiment 5

- Participants. 80 undergraduates
- Materials.
  - All reference objects have intrinsic sides
  - High verbal discriminability scenes  
(one kind of mismatch)
- Procedure
  - Shadow a message heard through headphones into a microphone
  - Match two configurations

# Results E5



Avoid process-interference



# Summary of findings

- Low verbal discriminability leads to use of mental rotation
- High verbal discriminability leads to use of verbal descriptions
- On average, mental rotation takes more time than verbal descriptions
- People avoid process-switching when performing tasks in sequence
- People avoid process-interference when performing tasks simultaneously

# Conclusions

- Recognizing configurations involves the spontaneous use of language
- Comparisons across perspectives lead to the use of language  
(as opposed to comparison from the same perspectives, e.g., Nelson & Brooks, 1973; Babbitt, 1982; Crawford, Regier & Huttenlocher, 2000; Munnich, Landua, & Doshier, 1997; Nelson & Reed, 1976; Rowe & Rogers, 1975)
- When verbal descriptions don't discriminate, people recognize configurations using mental rotation
- Timing of multitasking affects how people process spatial configurations