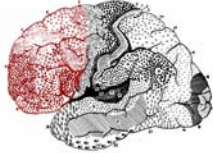


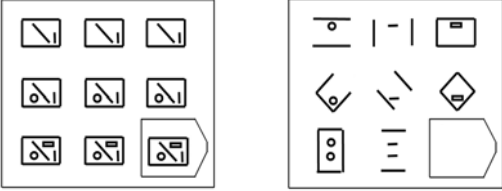
2006 Summer School, Sofia, Bulgaria
 July 4, 2006

Cognitive Neuroscience of Thought
 Kalina Christoff

Goal-directed Thought



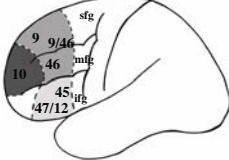
The Contribution of Lateral Prefrontal Cortex



How do we think about goal-directed thought?

A set of distinct component processes

- *can be described fairly precisely*
 - psychological nature
 - neural basis
- *are organized by particular principles*



RLPFC (BA 10)	↕	Rostralateral prefrontal cortex
DLPFC (BA 9, 46, 9/46)	↕	Dorsolateral prefrontal cortex
VLPFC (BA 45, 47/12)	↕	Ventrolateral prefrontal cortex

Relational Complexity Framework

(Halford et al., 1984)

Level 0: **0 relations** must be considered

Level 1: **1 relation** must be considered

Level 2: **2 relations** must be considered
relational integration

The ability of relational integration

Occurs late in child development (Halford, 1984)

Unique to humans (Tomasello & Call, 1997)

Linked to prefrontal cortex (Robin & Holyoak, 1995)

Specific deficit with frontal lesions (Waltz et al., 1999)

Raven's Progressive Matrices

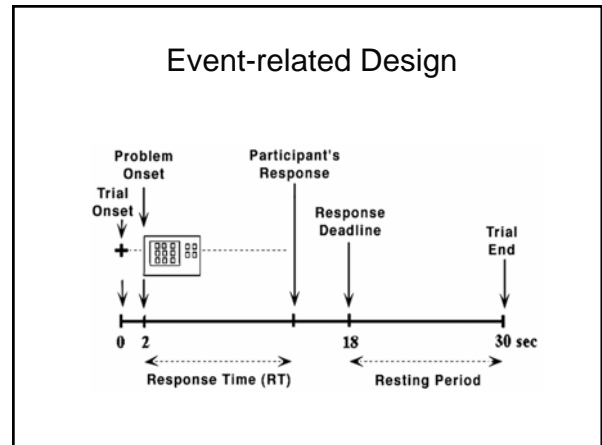
0-relational

Raven's Progressive Matrices

1-relational

Raven's Progressive Matrices

2-relational



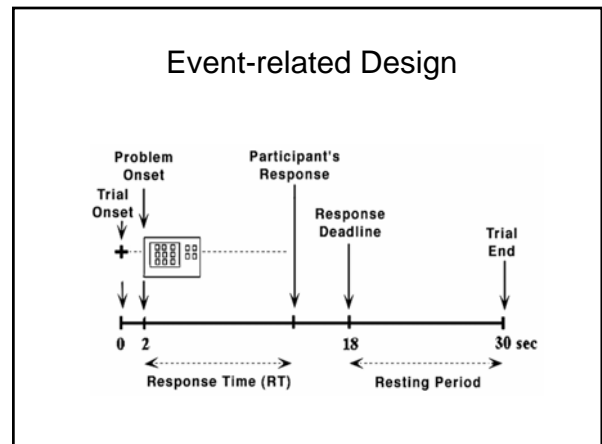
fMRI acquisition

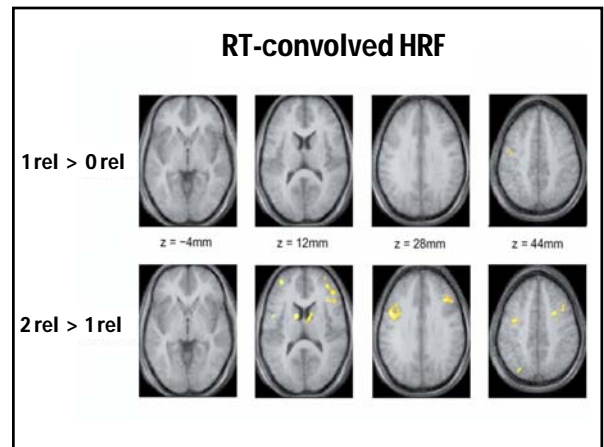
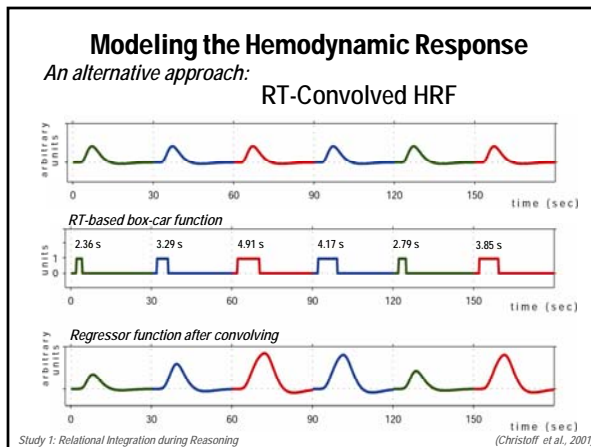
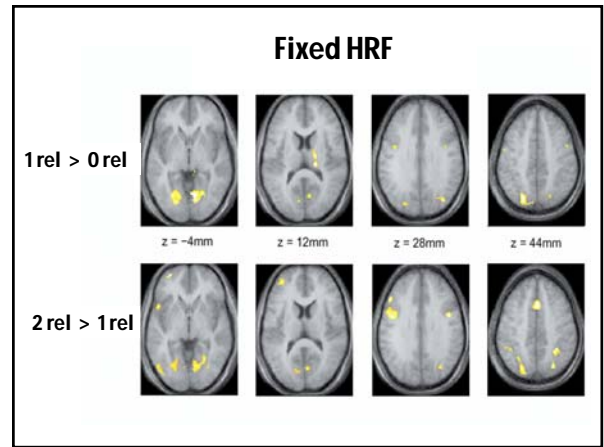
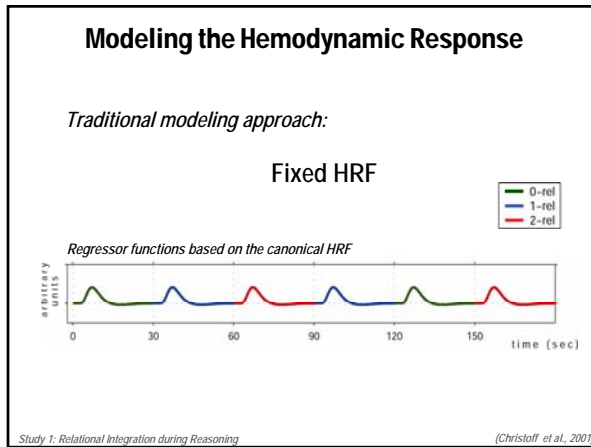
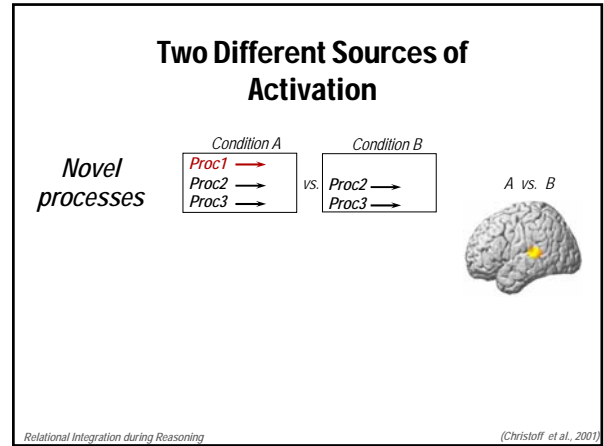
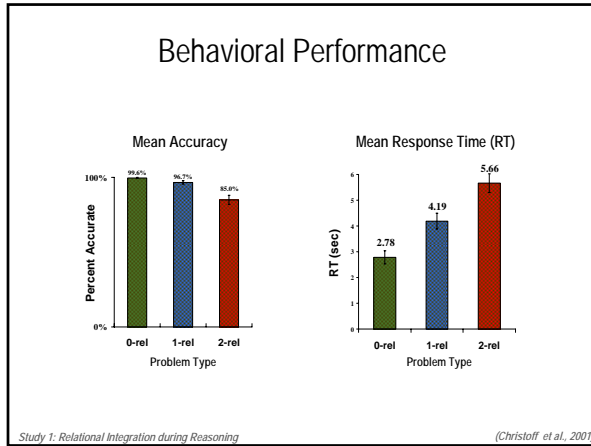
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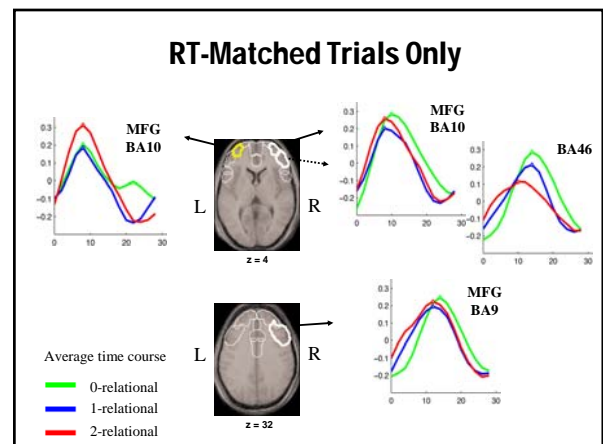
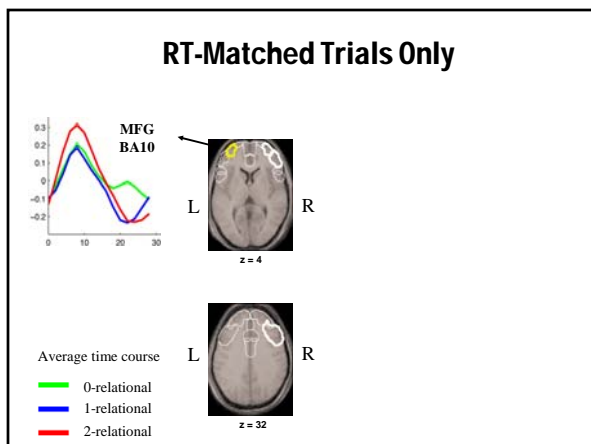
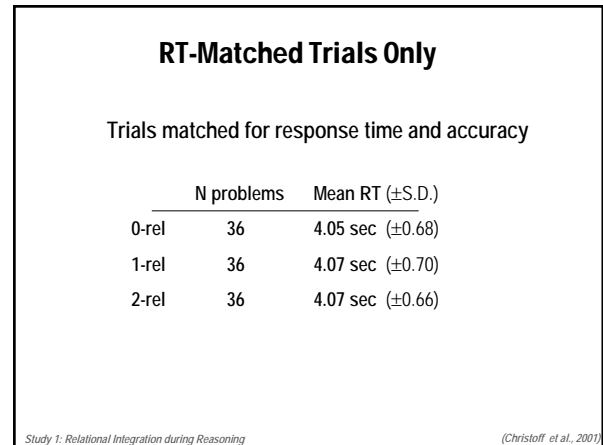
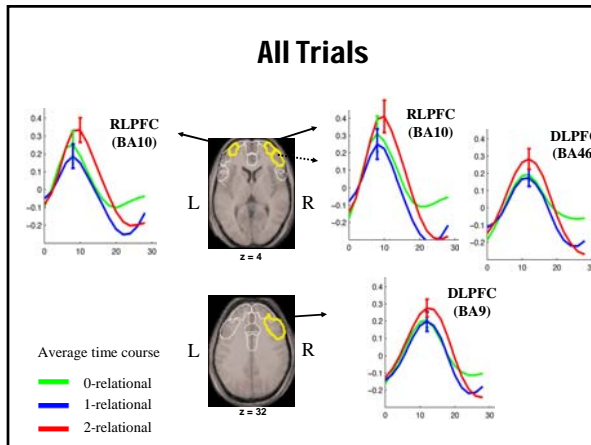
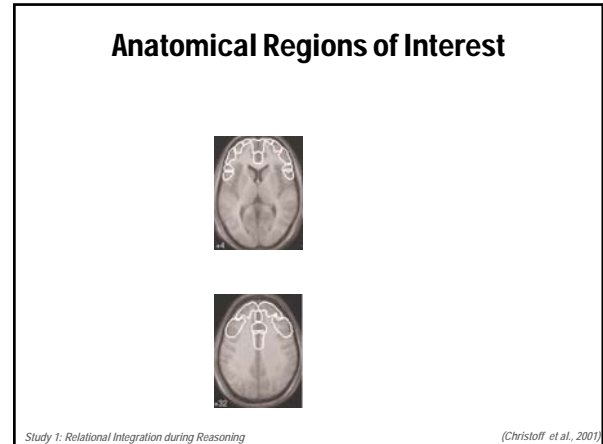
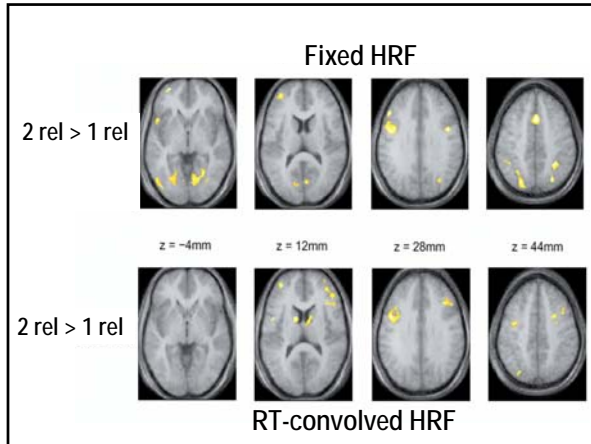
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- TR = 2 s
- 16 axial slices
- 7 mm slice thickness
- no spacing between slices
- spiral pulse sequence
- bite-bar
- 10 participants

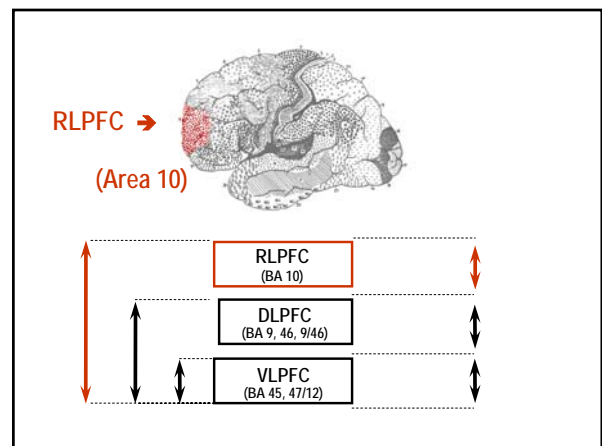
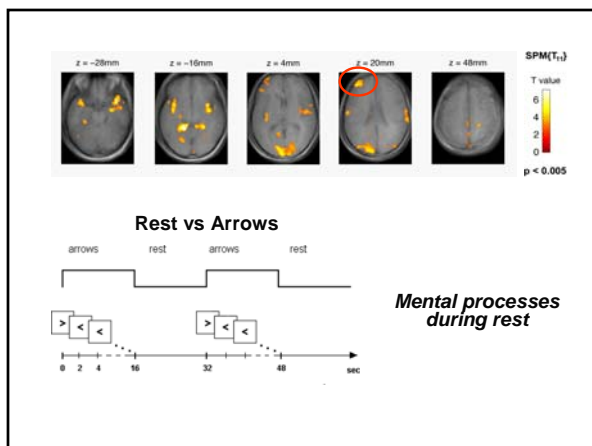
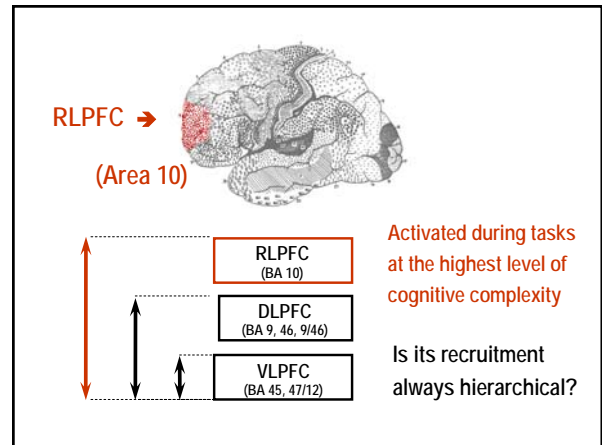
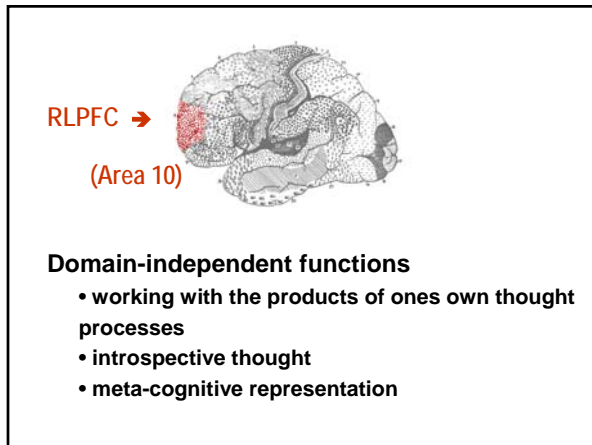
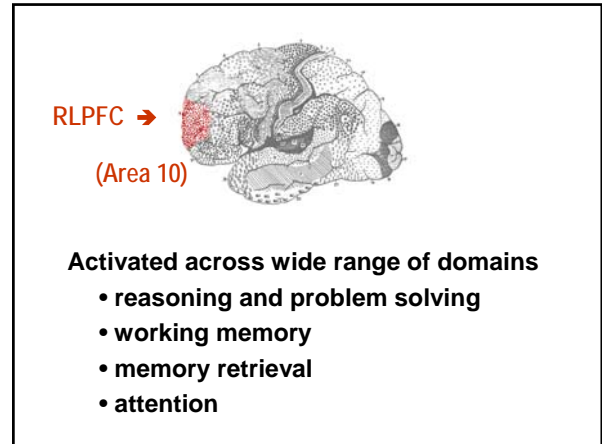
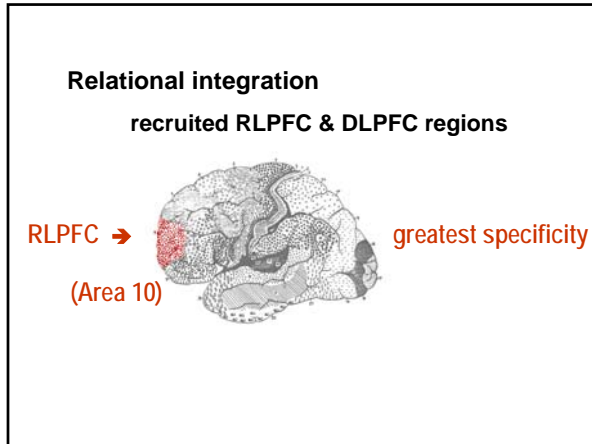
Functional analysis

- SPM 99b
- random effects model









Different levels of abstraction in thinking

Thought processes performed upon information that is

RLPFC (BA 10)	Highly abstract
DLPFC (BA 9, 46, 9/46)	Relatively abstract
VLPFC (BA 45, 47/12)	Relatively concrete

Executive processes: abstract vs. concrete information

- Computational models of prefrontal function (O'Reilly et al., 2002)
- Developmental models of executive functions (Zelazo et al., 1999, 2004)

Continuum

Abstract Concrete

Redness Red Car Red BMW Your own BMW

Patterns of connectivity

Pandya & Barnes (1987)

Rostrocaudal (anterior-to-posterior) gradient:
 More anterior PFC regions are connected to areas of increasing order of association in posterior cortices.

Abstract Medium Concrete

200 250 300 350 400 450 500 550 600 650 700

Concreteness ratings for nouns

Paivio et al. (1968), MRC Psycholinguistic Database (Wilson, 1988)

Solving Anagrams

Abstract	Medium	Concrete
A P e a l p	D n c a e	D k e s
H m a r	T p i r	F o d o
G a c r e	S n g o	B O l t e t

Christoff, Keramatian et al. (in prep)

Solving Anagrams

Abstract	Medium	Concrete
A P e a l p <i>(Appeal)</i>	D n c a e <i>(Dance)</i>	D k e s <i>(Desk)</i>
H m a r <i>(Harm)</i>	T p i r <i>(Trip)</i>	F o d o <i>(Food)</i>
G a c r e <i>(Grace)</i>	S n g o <i>(Song)</i>	B o l t e t <i>(Bottle)</i>

Instructions (2 sec)

Stimuli (4 sec each)

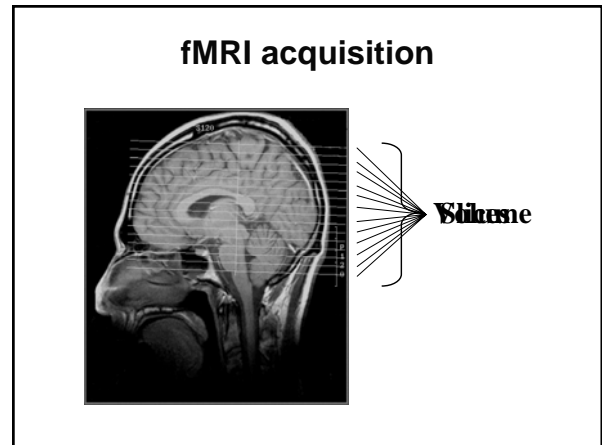
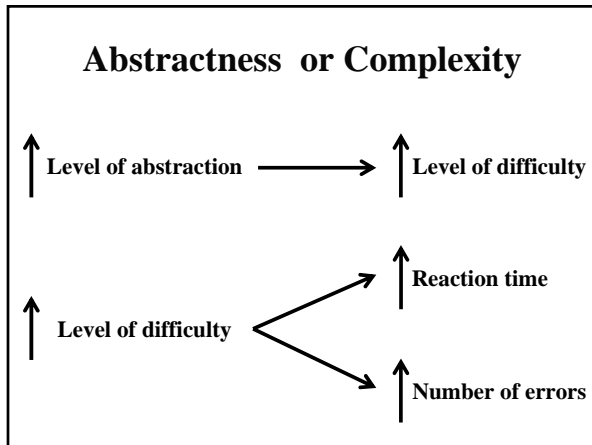
Abstract: Whis (*wish*)

Medium: Fvere (*fever*)

Concrete: Bkna (*bank*)

8 stimuli per block, 12 blocks per condition
 conditions matched for

- word frequency (M=53)
- word length (M=5.37)
- number of syllables (M=1.5)
- difficulty



Behavioral Pilot Study

D e c a n	D a c e n	D a n e c	Dance
Very difficult	Fairly difficult	Easy	Solution

