



ICON -- JULY 2014 -- BRISBANE

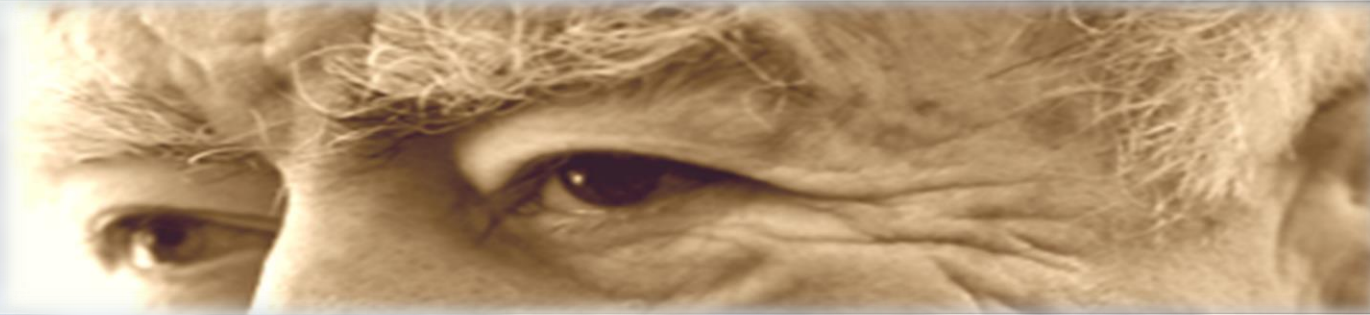


UNIVERSITEIT VAN AMSTERDAM

k.r.ridderinkhof@uva.nl

LEARNING IN OLD AGE

A NETWORK APPROACH



K. RICHARD RIDDERINKHOF
UNIVERSITEIT VAN AMSTERDAM



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*Amsterdam center for the study of
adaptive control in brain and behavior*



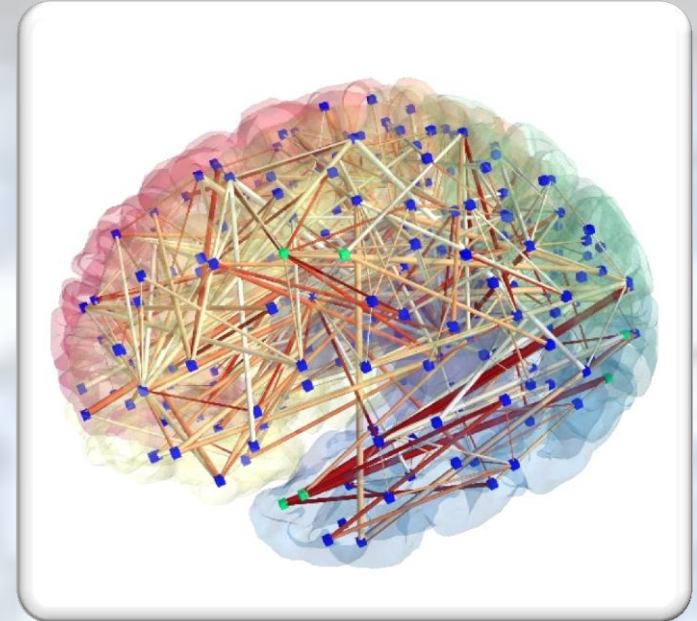
A NETWORK APPROACH



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◆ Network connectivity

- ◆ in adaptive control
 - ◆ learning stimulus-response-outcome contingencies from feedback



A C A C i A

V C V C ! V



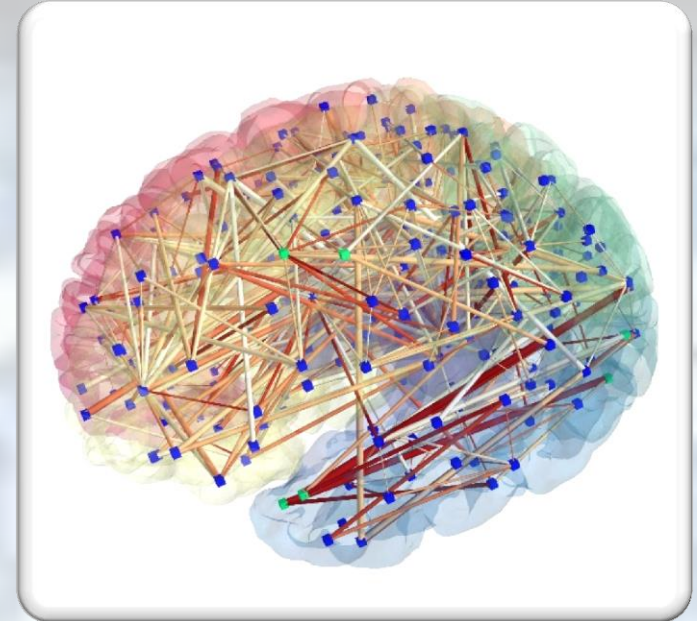
A NETWORK APPROACH



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◆ Network connectivity

- ◆ in adaptive control
 - ◆ learning stimulus-response-outcome contingencies from feedback
- ◆ (age-related) individual differences



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A NETWORK APPROACH



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◆ Roadmap / Contour of the Talk

- ◆ Probabilistic learning
 - ◆ EEG t/f decomposition analysis
 - ◆ seed-based probabilistic tracking DTI
- ◆ Goal-directed vs. habit learning
 - ◆ behavioral
 - ◆ seed-based probabilistic tracking DTI



A C A C i A

V C V C ! V



Learning which actions lead to the desired goal:

connectivity profiles predict
future learning from negative feedback

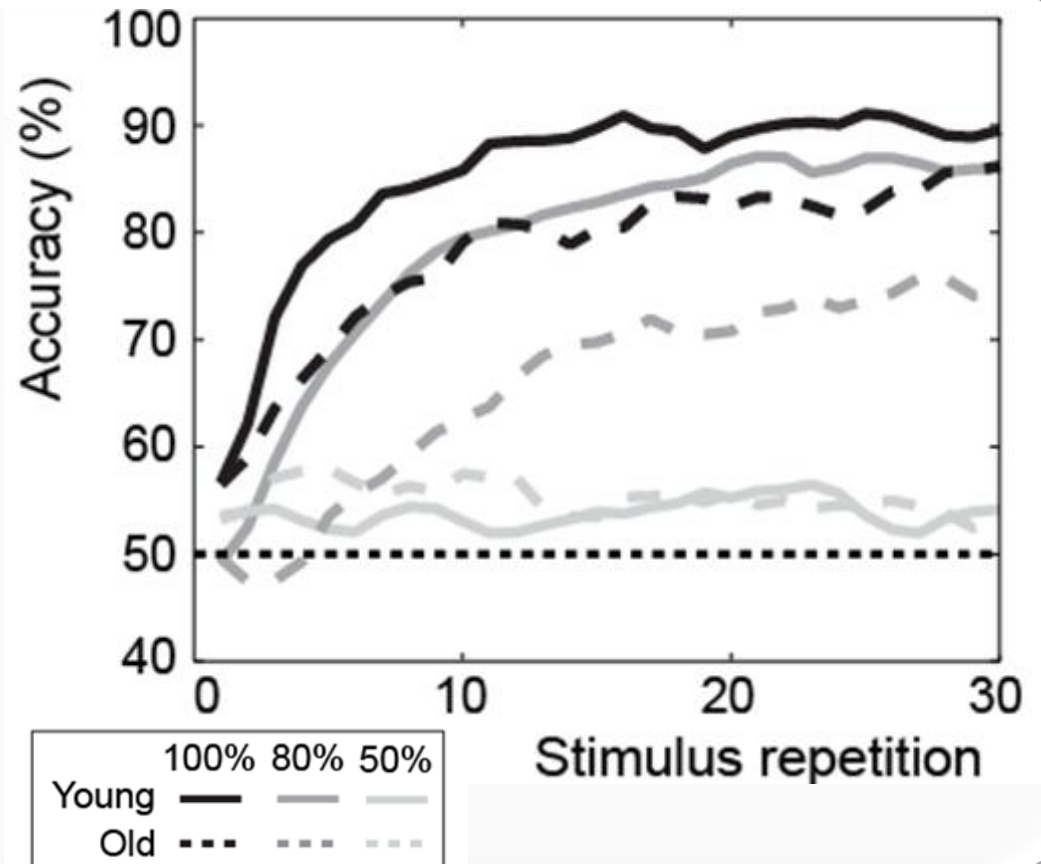
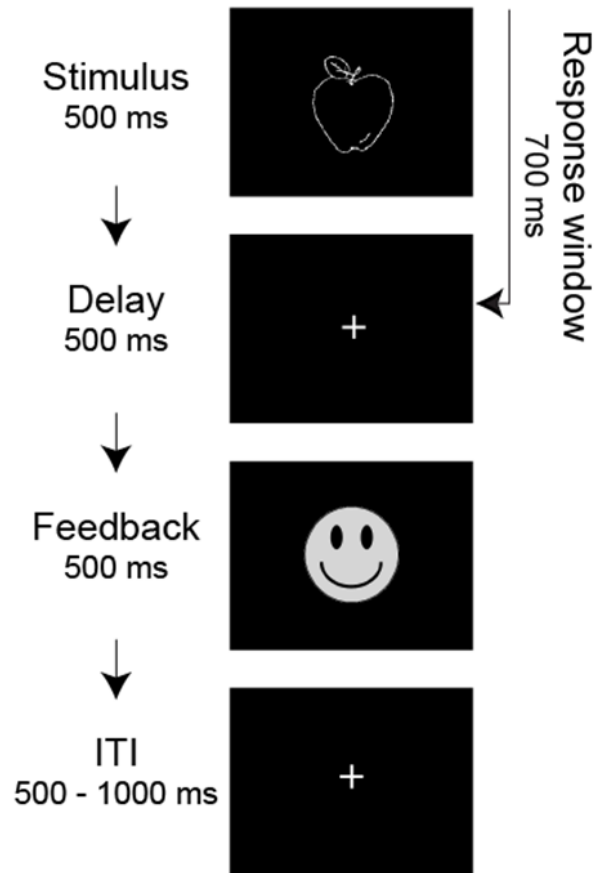




PROBABILISTIC LEARNING



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Goal: learn that response X to stimulus A yields reward

A C A C i A

van de Vijver, Cohen & Ridderinkhof (*Neurobiology of Aging* 2014)

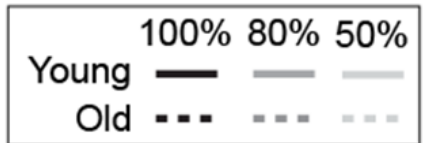
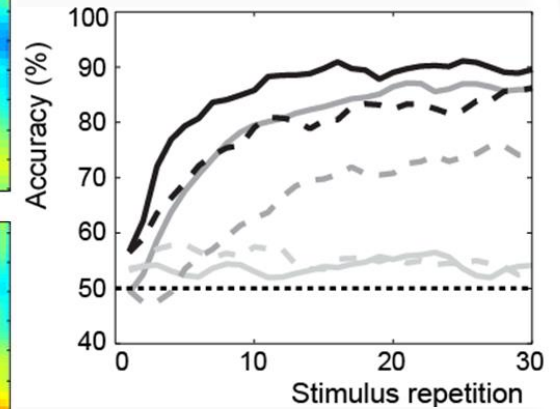
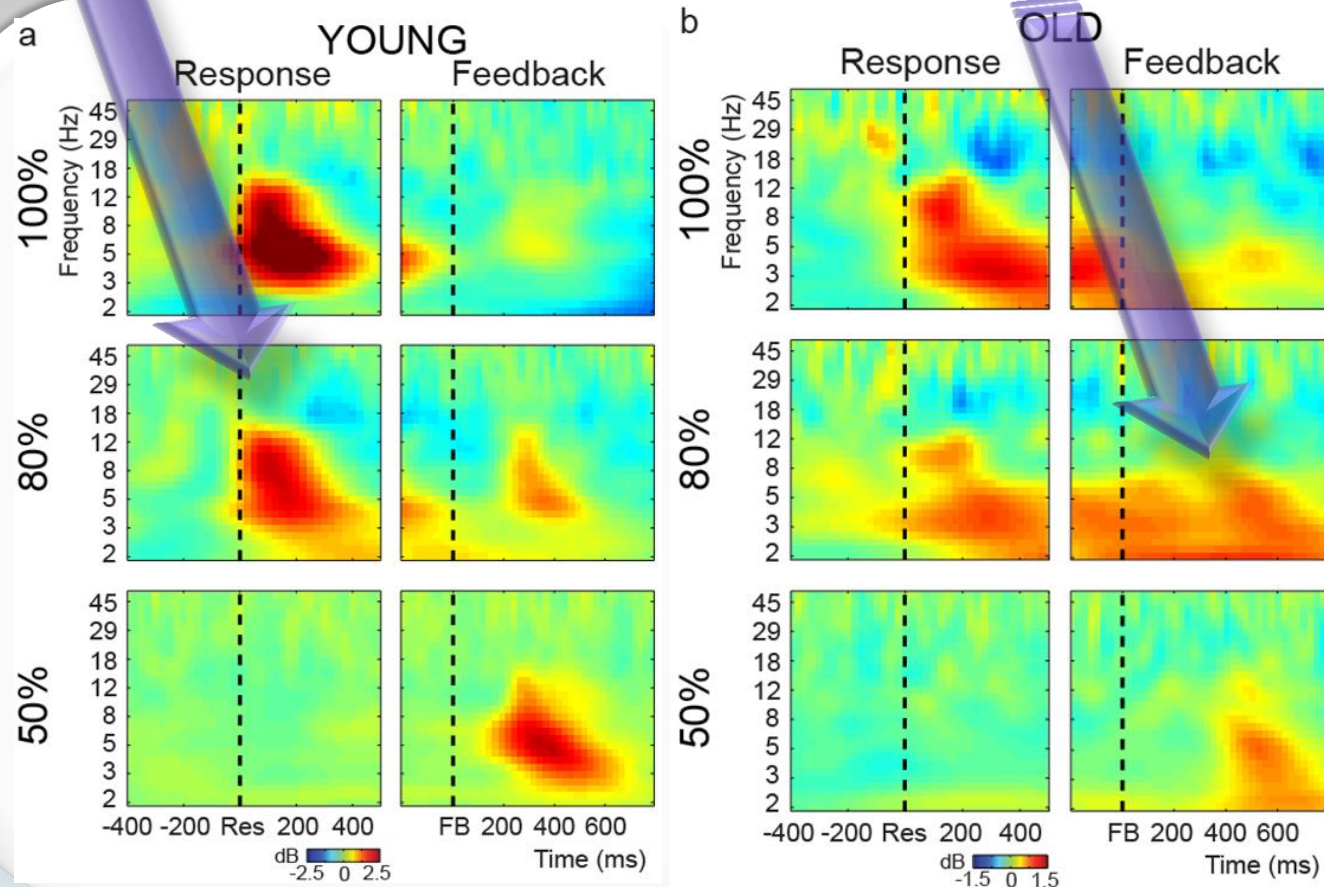
V C V C i V



PROBABILISTIC LEARNING



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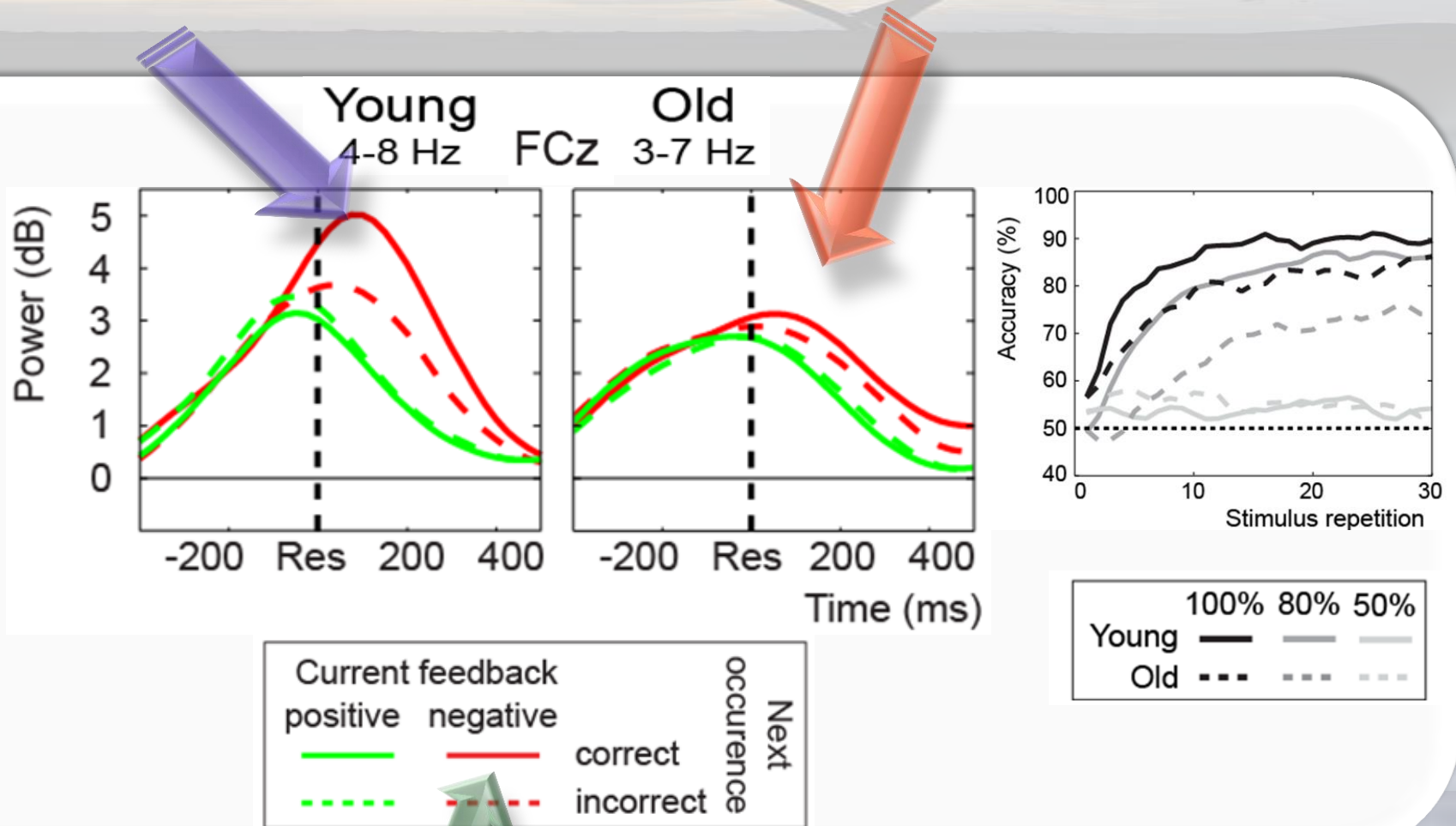


A C A C i A

van de Vijver, Cohen & Ridderinkhof (*Neurobiology of Aging* 2014)



PROBABILISTIC LEARNING



- Learning from Loss: predicted by MFC theta power

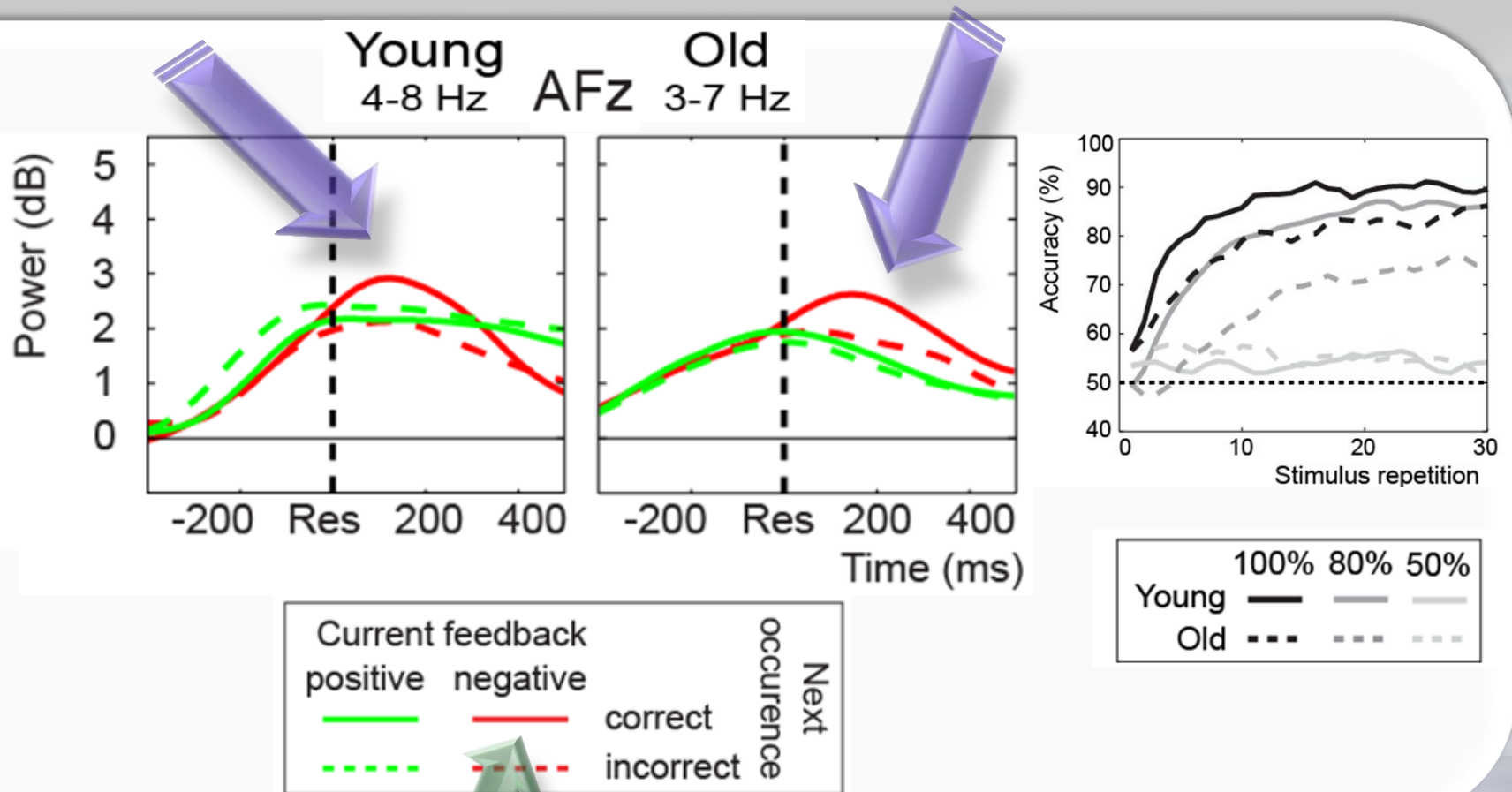
A C A C i A

van de Vijver, Cohen & Ridderinkhof (*Neurobiology of Aging* 2014)

V C V C i A



PROBABILISTIC LEARNING



- Learning from Loss: predicted by AFz theta power

A C A C i A

van de Vijver, Cohen & Ridderinkhof (*Neurobiology of Aging* 2014)

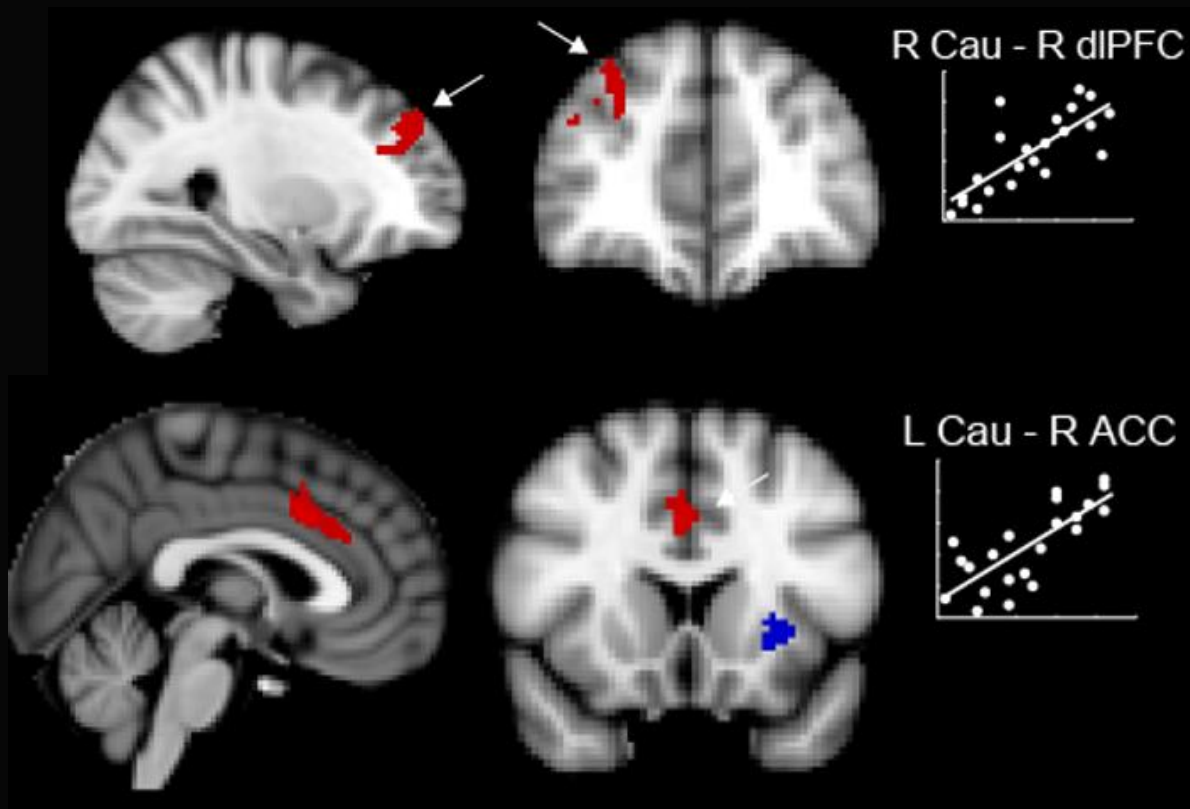
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PROBABILISTIC LEARNING



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YOUNG

- Learning from Loss: predicted by connectivity from caudate to dlPFC/ACC

A C A C i A

V C V C ! V

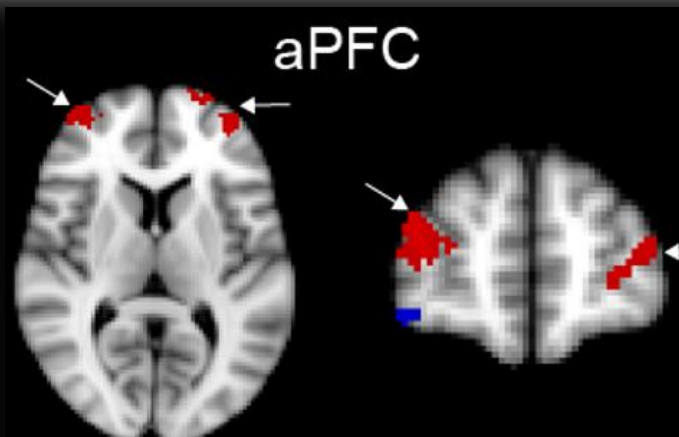
van de Vijver, Ridderinkhof,, & Cohen (*subm*)



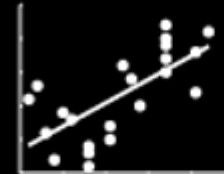
PROBABILISTIC LEARNING



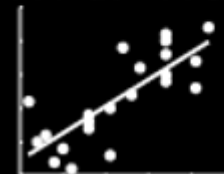
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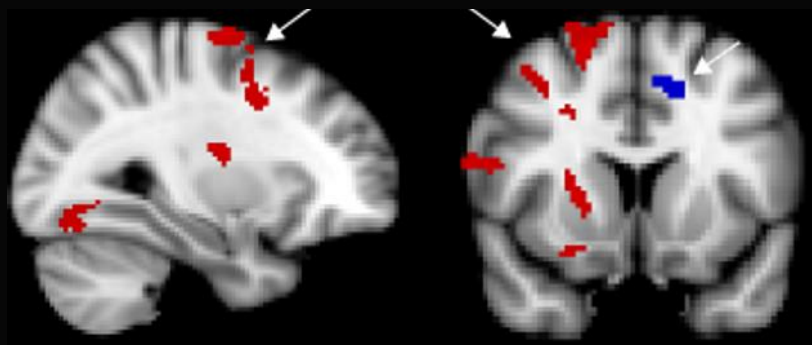
L Put - L aPFC



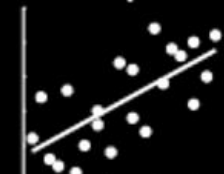
R Put - R aPFC



OLD



Put - L SMA/premotor



- Learning from Loss: predicted by connectivity from putamen to aPFC/SMA/Premotor

A C A C i A

van de Vijver, Ridderinkhof, ..., & Cohen (*subm*)

V C V C ! V



◆ INTERIM CONCLUSIONS

- ◆ accuracy on the next presentation of the same stimulus is predicted by
 - ◆ Young :
 - ◆ medial frontal and anterior frontal theta
 - ◆ structural connectivity between caudate and MFC / dlPFC
 - ◆ Older adults :
 - ◆ anterior frontal but not medial frontal theta
 - ◆ structural connectivity between putamen and premotor / aPFC



◆ INTERIM CONCLUSIONS

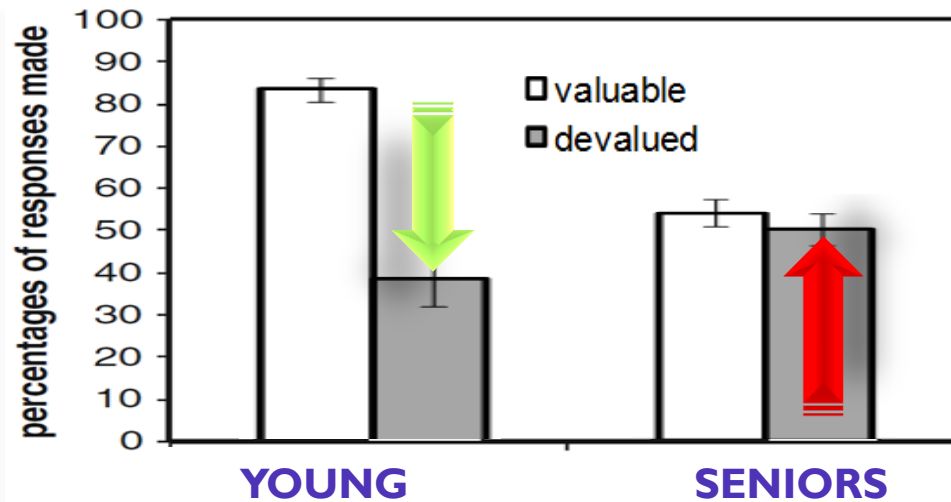
- ◆ Aging :
 - ◆ with deficient MFC mechanisms,
older adults may depend more on frontopolar mechanisms
 - ◆ e.g., tracking behavioral alternatives such as competing but previously unchosen options
 - ◆ with deficient caudate-based mechanisms,
older adults may depend more on putamen-based mechanisms
 - ◆ e.g., shifting from goal-directed to habitual action



HABITUAL VS. GOAL-DIRECTED ACTION



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Aging tips the balance from goal-directed action
to habitual action (*more slips of action*)

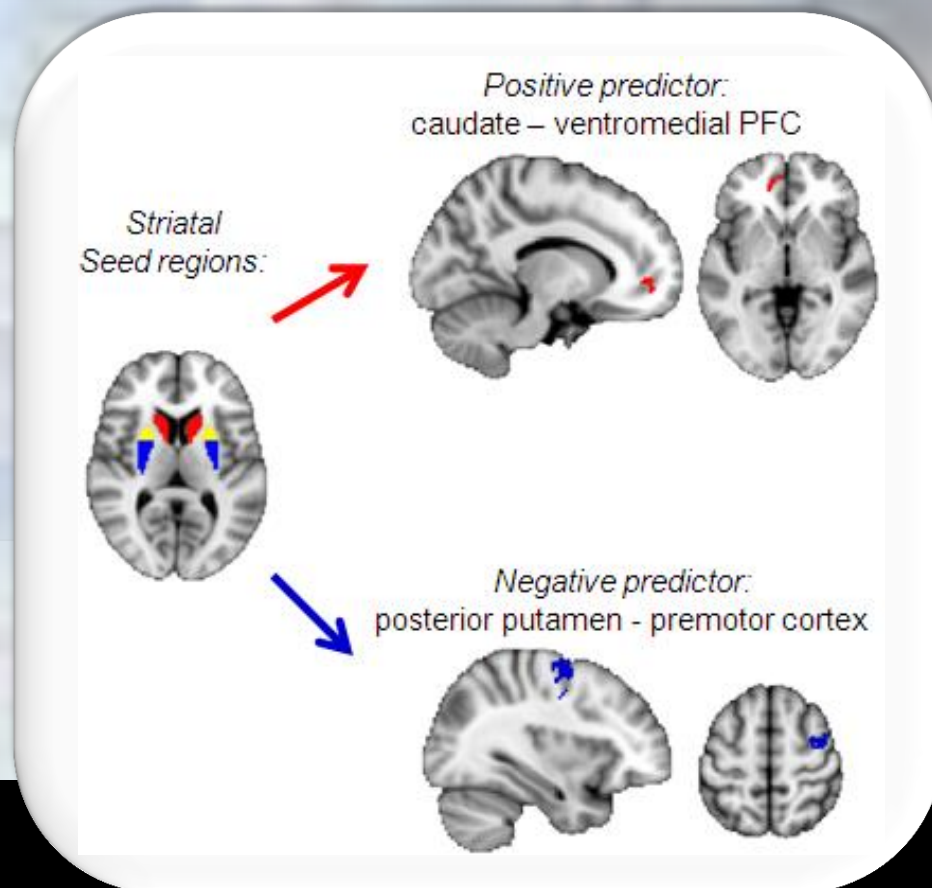
De Wit *et al.* (CABN 2014)

A C A C i A

V C V C ! V



- ◆ **Structural Connectivity study (DTI)**
 - ◆ frontostriatal connectivity key to balancing **Goal-Directed vs. Habitual Action**



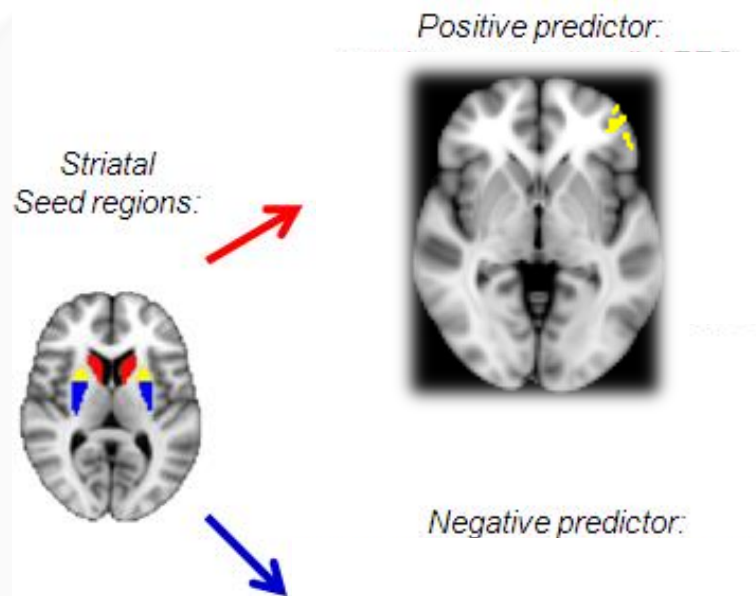


HABITUAL VS. GOAL-DIRECTED ACTION



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- ◆ **Structural Connectivity study (DTI)**
 - ◆ frontostriatal connectivity key to balancing **Goal-Directed vs. Habitual Action**



A C A C i A

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Watson et al., *in prep*



HABITUAL VS. GOAL-DIRECTED ACTION



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◆ INTERIM CONCLUSIONS

◆ Goal-directed vs habitual learning

◆ Young :

- ◆ goal-directed action supported by caudate – OFC network
- ◆ habitual action supported by putamen – premotor network

A C A C i A

V C V C ! V



HABITUAL VS. GOAL-DIRECTED ACTION



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◆ INTERIM CONCLUSIONS

◆ Goal-directed vs habitual learning

◆ Young :

- ◆ goal-directed action supported by caudate – OFC network
- ◆ habitual action supported by putamen – premotor network

◆ Older adults :

- ◆ goal-directed action supported by caudate – aPFC network
- ◆ habitual action ??
 - ◆ (also not with whole-brain based TBSS)

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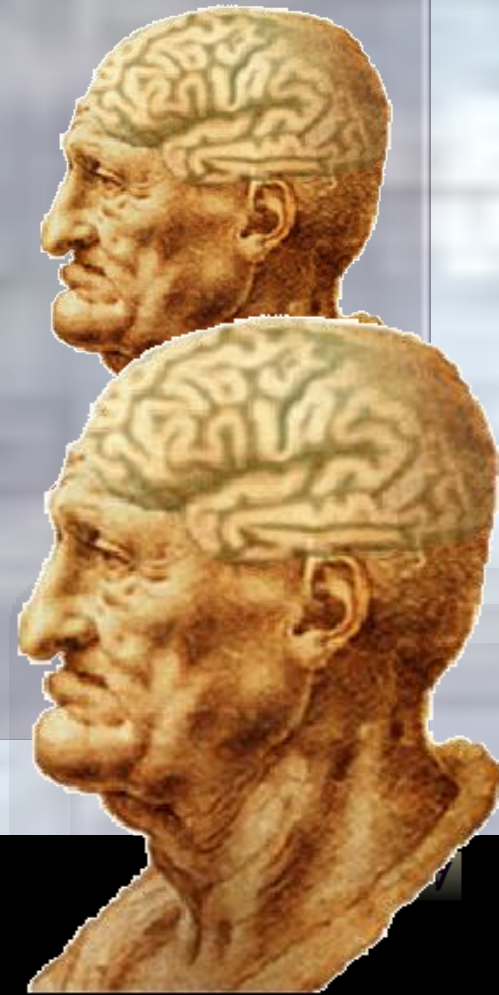
A NETWORK APPROACH



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◆ OVERALL CONCLUSIONS

- ◆ as our brains grow older
 - ◆ network profiles change
 - ◆ e.g., from MFC-centered to AFC-centered





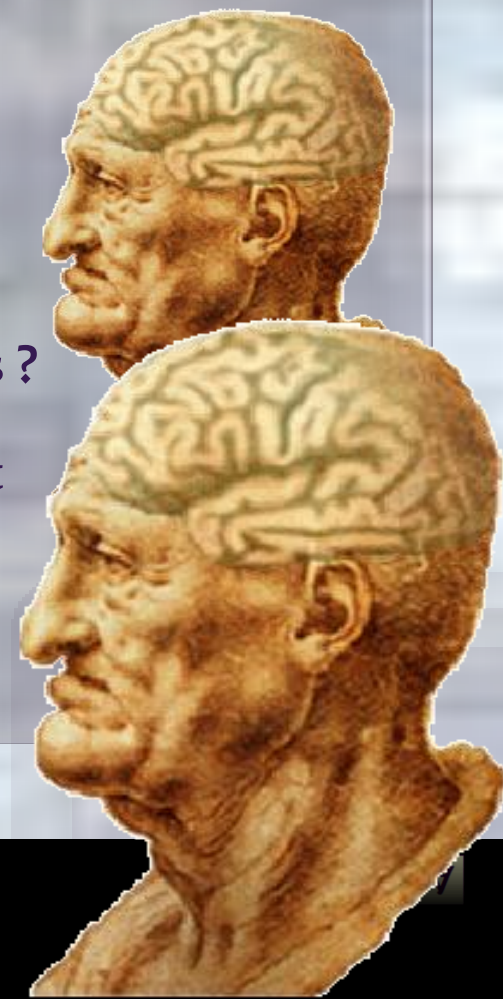
A NETWORK APPROACH



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◆ OVERALL CONCLUSIONS

- ◆ as our brains grow older
 - ◆ network profiles change
 - ◆ e.g., from MFC-centered to AFC-centered
 - ◆ inter-individual variability in pathways increases ?
 - ◆ covariance-based neuroimaging falling apart

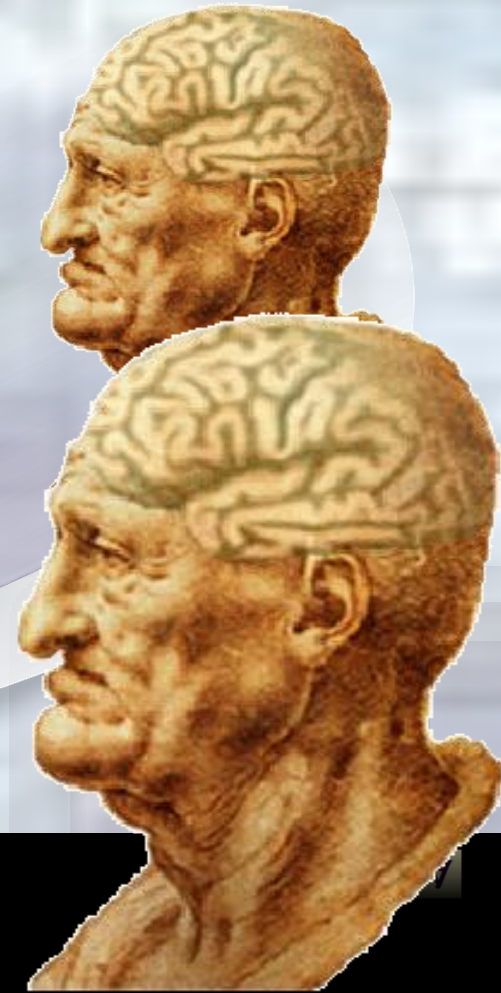




THANKS FOR YOUR ATTENTION

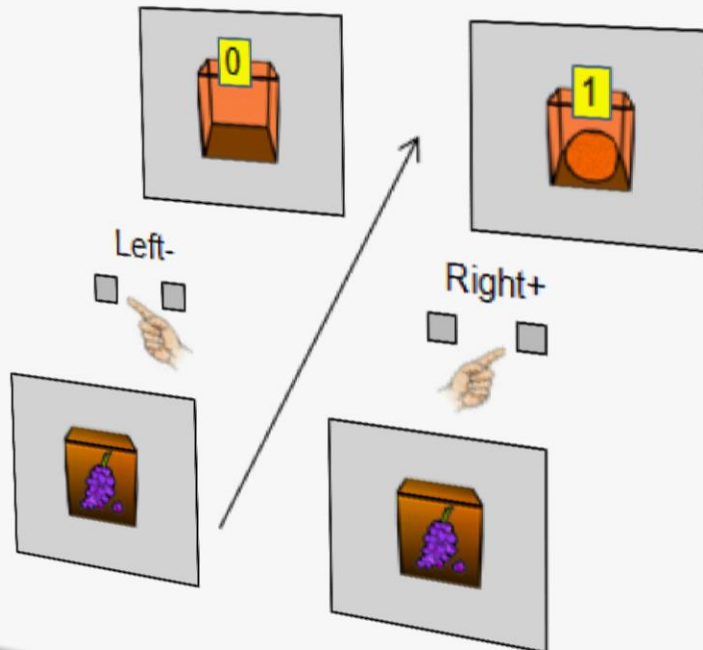


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a. Instrumental learning stage



b. Discrimination types

Standard discrimination:

If  Then Right → 

If  Then Left → 

Congruent discrimination:

If  Then Right → 

If  Then Left → 

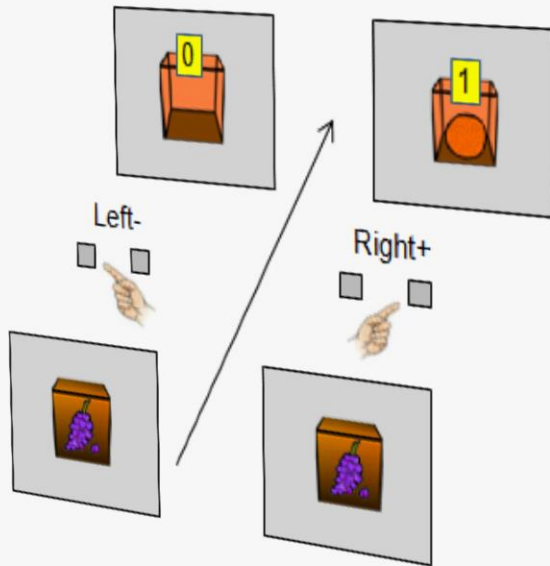
Incongruent discrimination:

If  Then Right → 

If  Then Left → 

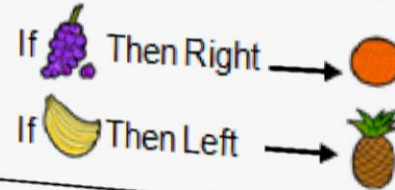


a. Instrumental learning stage

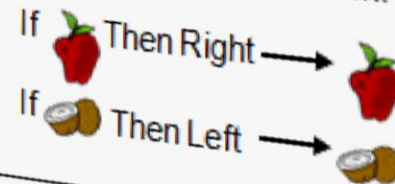


b. Discrimination types

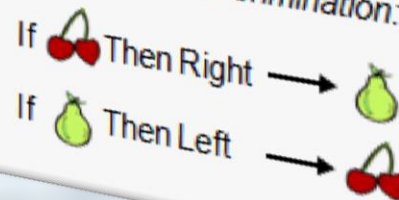
Standard discrimination:



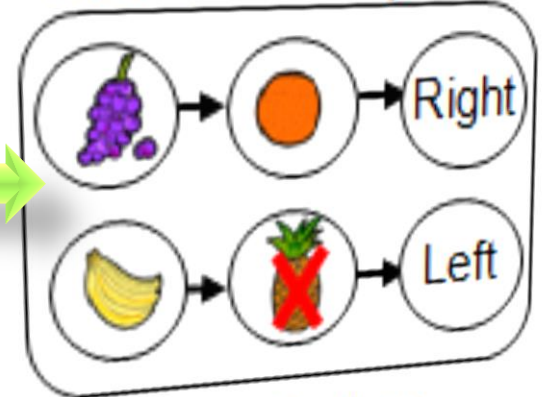
Congruent discrimination:



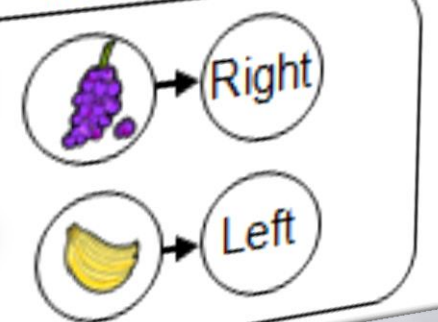
Incongruent discrimination:



Goal-directed System

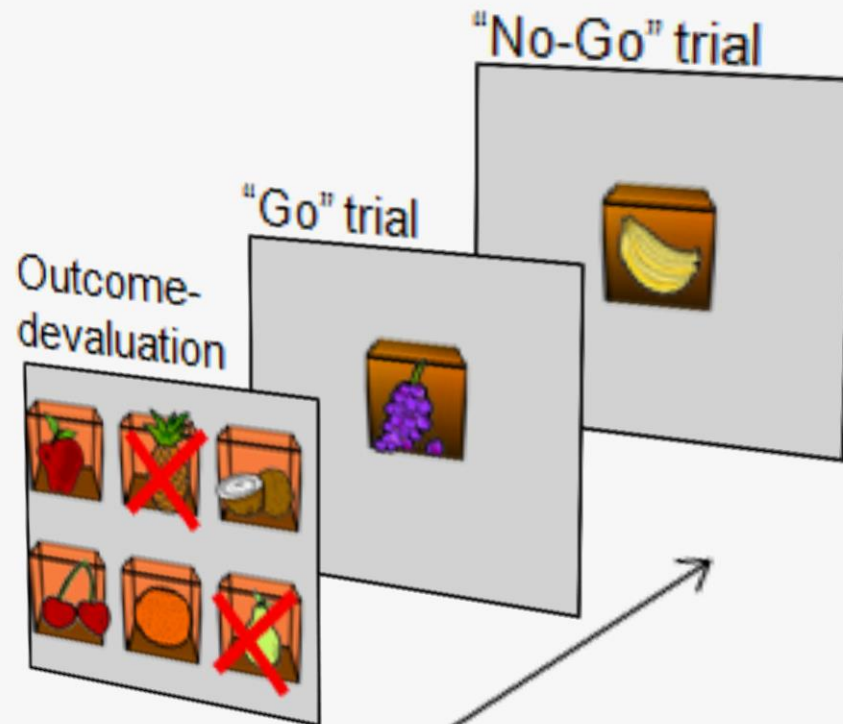


Habit System

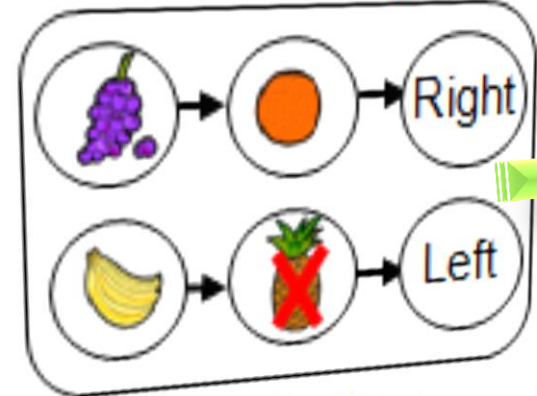




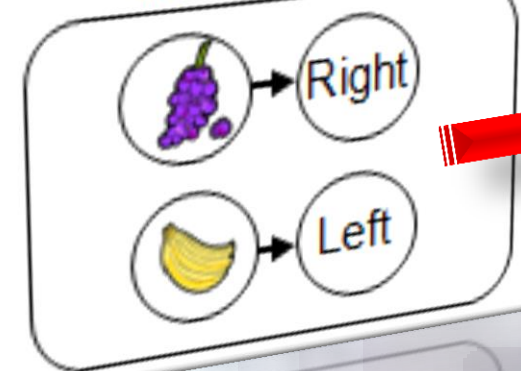
c. Slips-of-action test



Goal-directed System



Habit System

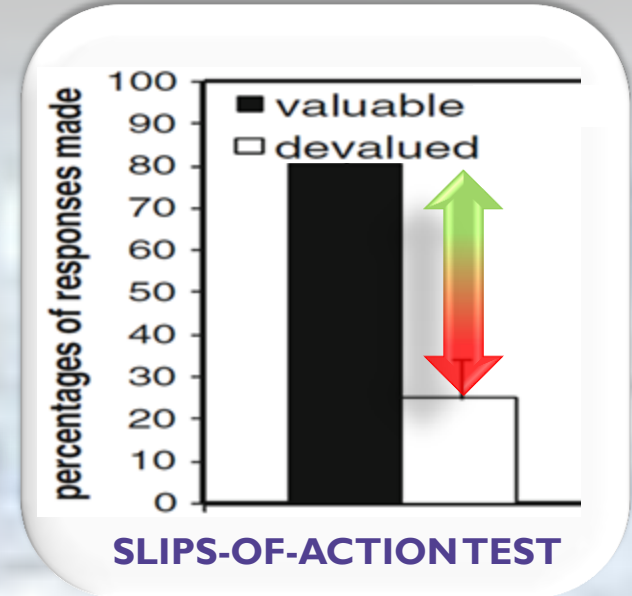
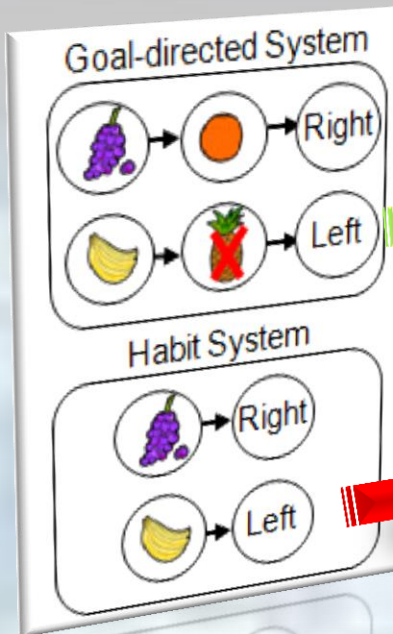
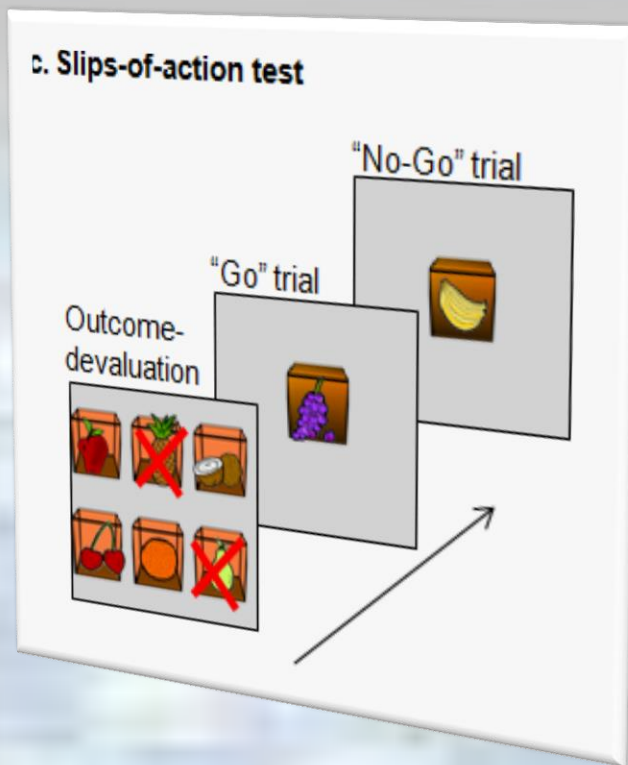




Habitual *versus* Goal-Directed Action



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Individuals who *rely more on habitual action* will show *more slips of action* than individuals who *rely more on goal-directed action*

SLIPS-OF-ACTION TEST

A C A C i A

V C V C ! V