

Are there multiple memory systems?

Tests of models of implicit and explicit memory

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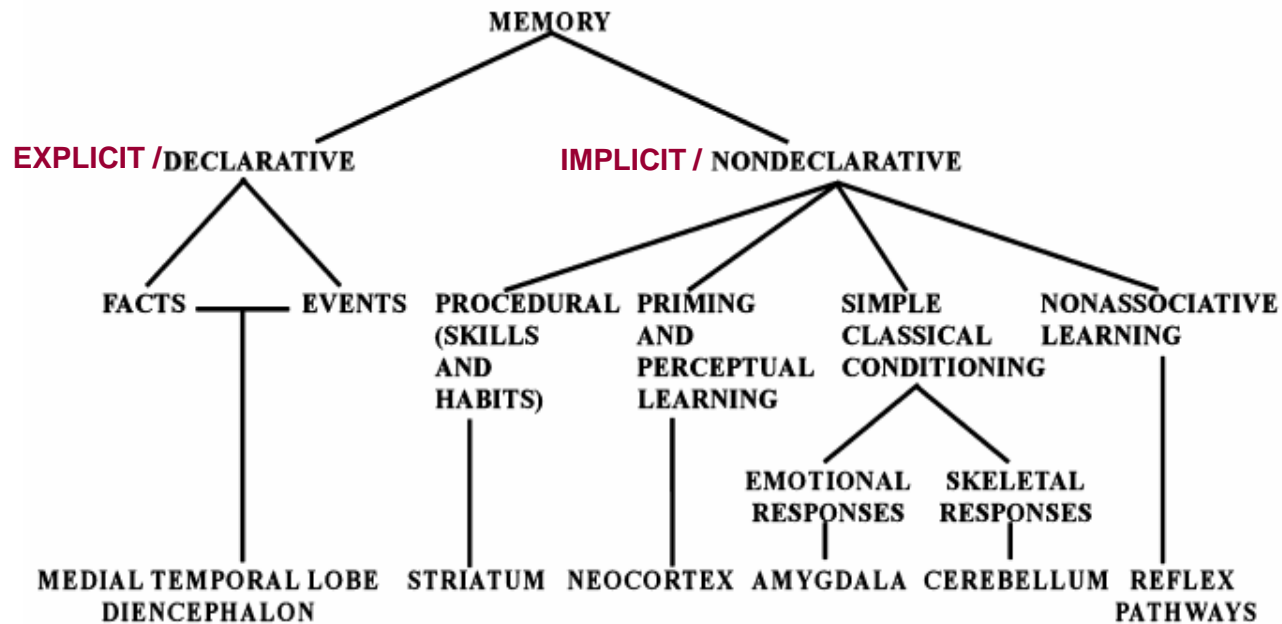
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with additional thanks to:

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Shelley Channon
Leonora Wilkinson

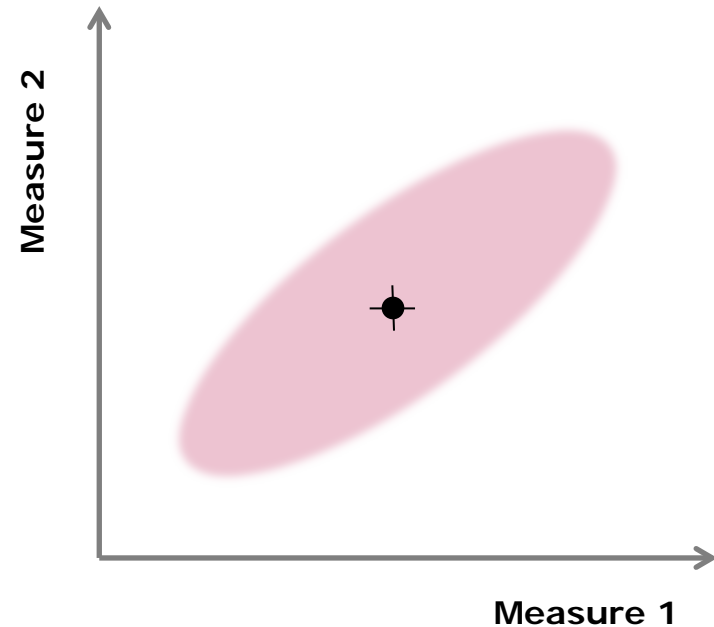
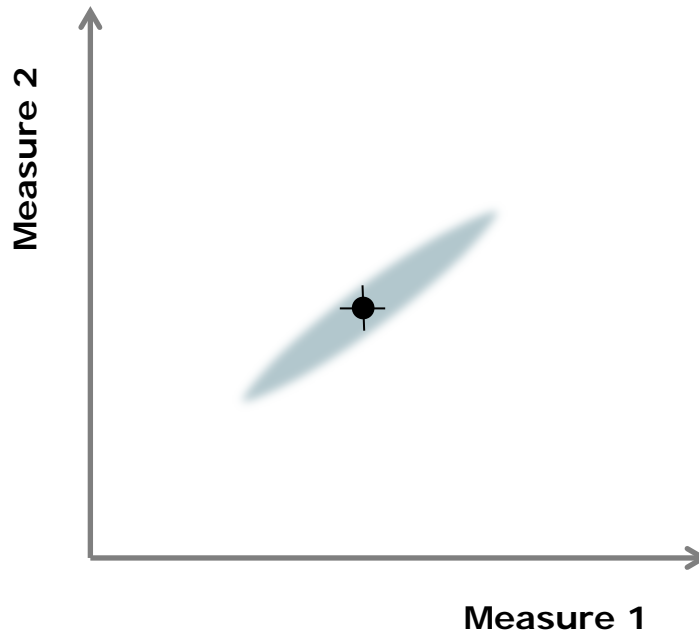
Memory systems



Recognition is driven by an explicit (declarative) memory system

Priming is driven by an implicit (non-declarative) memory system

Why computational models?



There is no pattern of data that can be fit by a restricted model but not by the general model

However, a pattern of data may provide stronger support for the restricted model. This is at the heart of Maximum Likelihood-based model selection techniques (such as AIC)

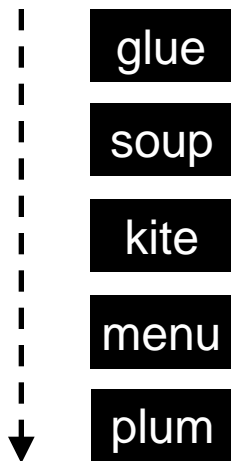
AIC helps guard against OVERFITTING

Outline

- The CID-R task for measuring recognition and priming concurrently
- A general, formal, framework for modelling priming and recognition
- Constructing single- and dual-system models within the framework
- Application to normal and amnesic data
- Conclusions and future prospects

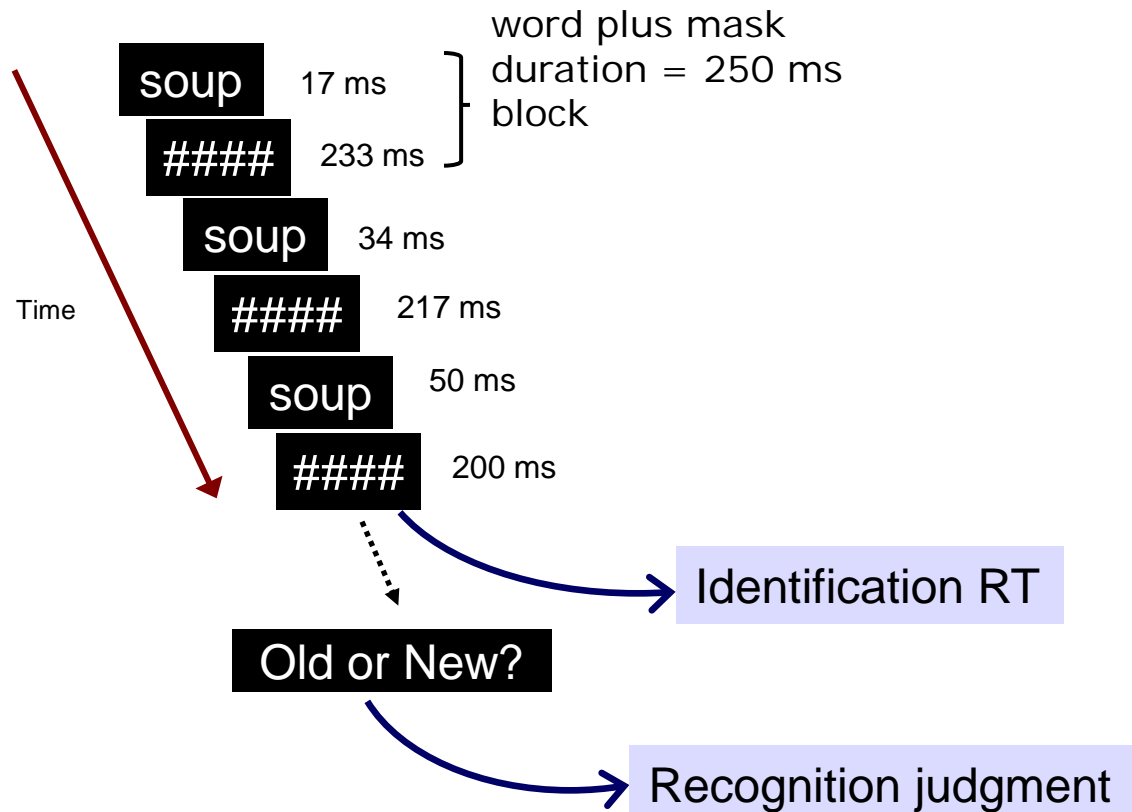
Measuring recognition and priming

Study Phase

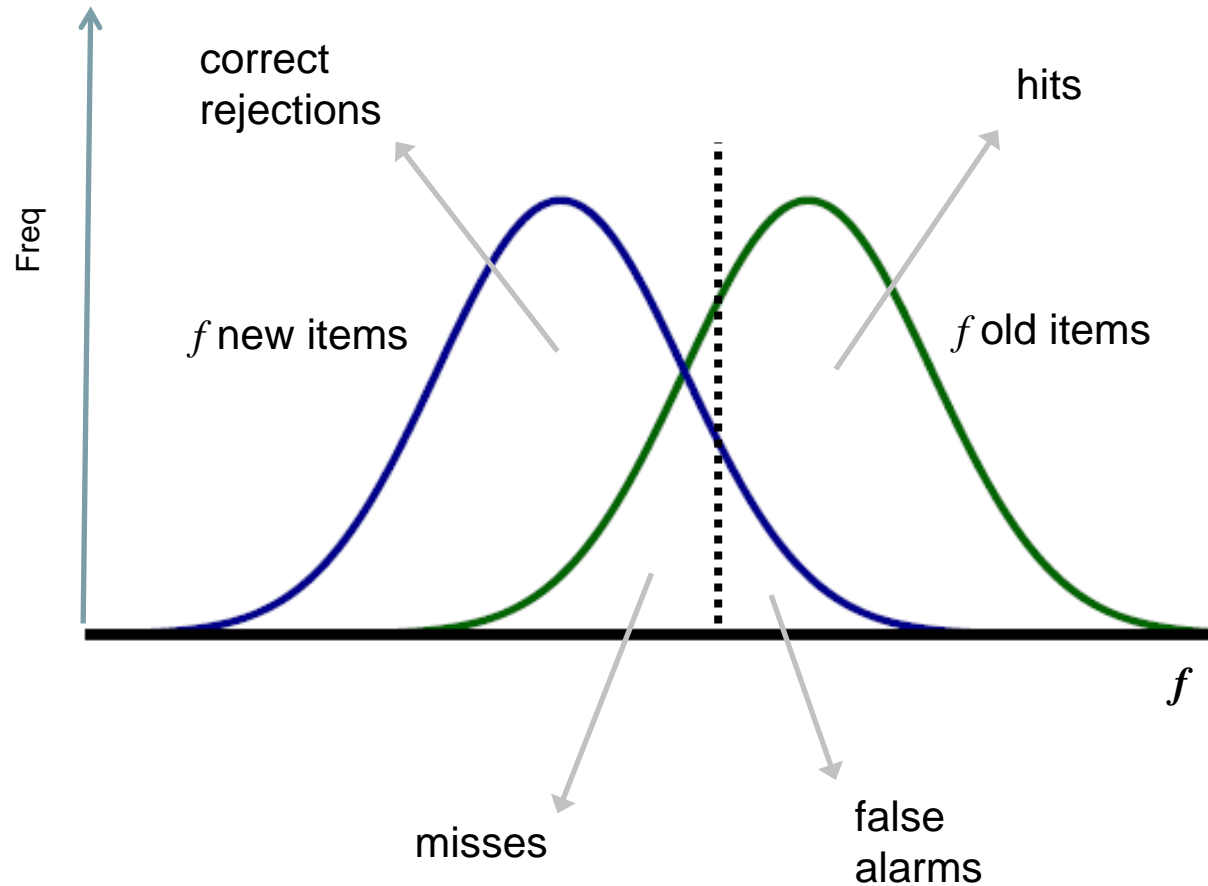


Test Phase

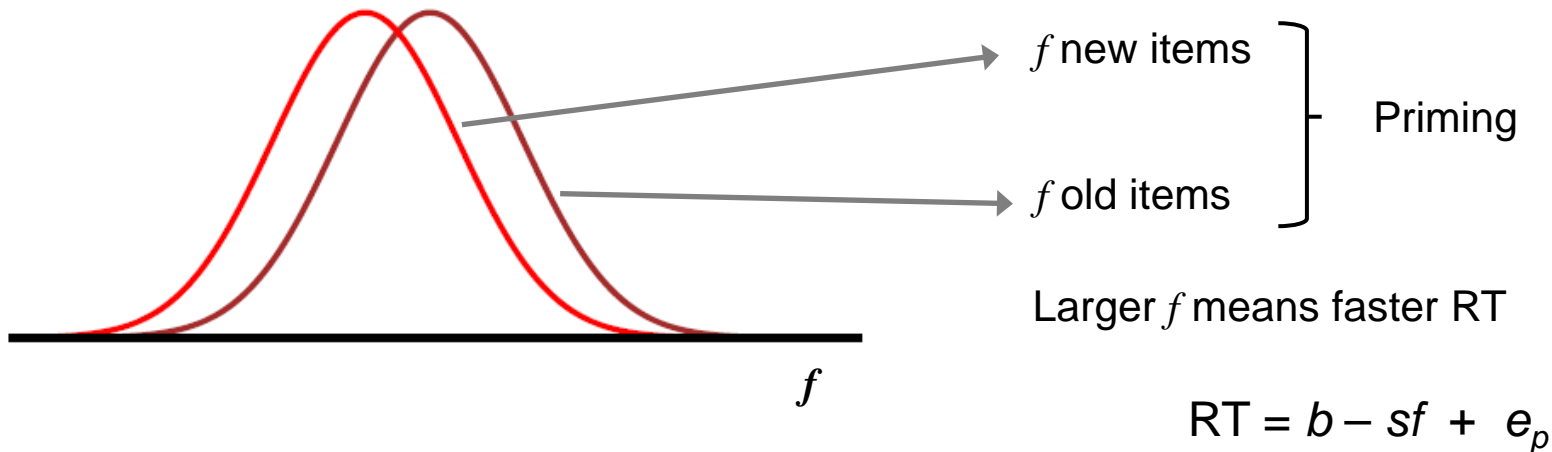
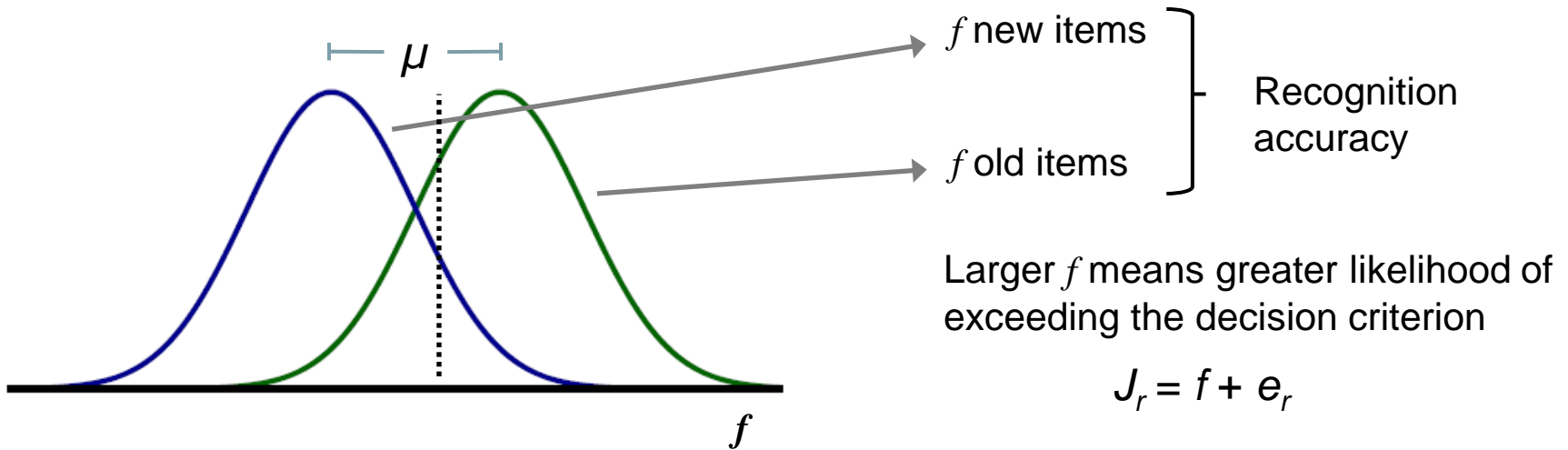
Continuous identification with recognition (CID-R) task



Signal Detection Theory

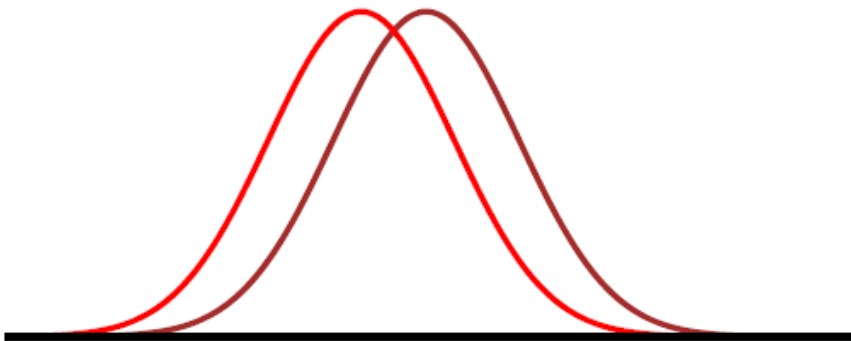
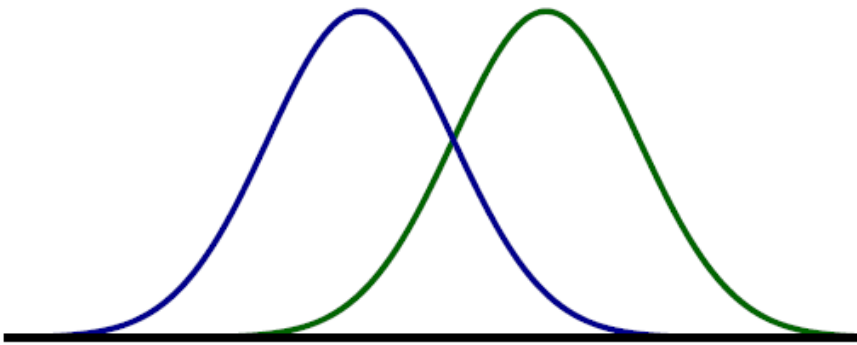


A theoretical framework



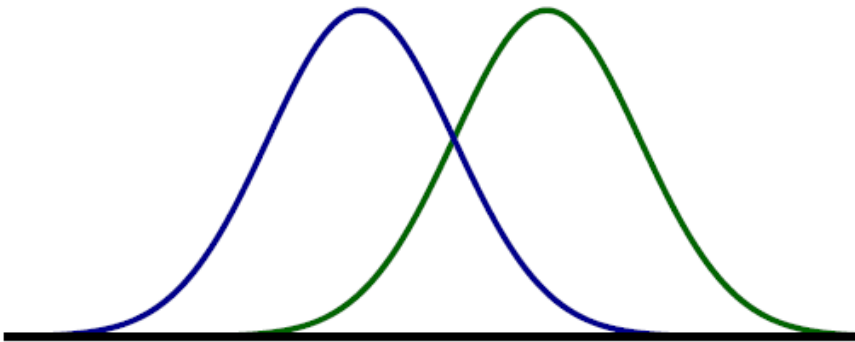
A theoretical framework

One possibility is that the distributions (i.e., memory sources) for recognition and priming are independent (Tulving)



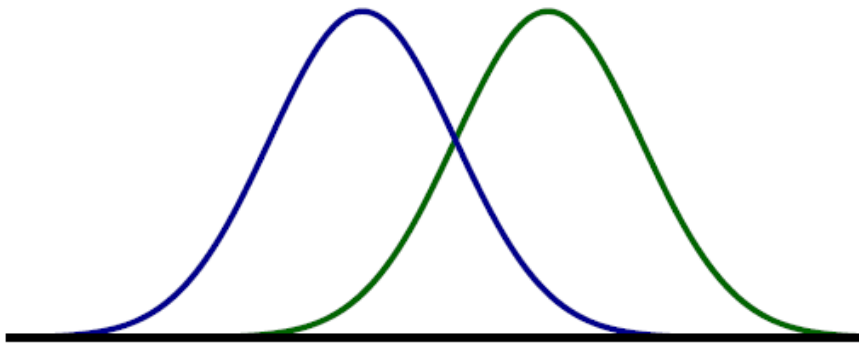
A theoretical framework

Another possibility is that the distributions for recognition and priming are identical – that is, there is only a single memory system. The exact same value of f that drives recognition also drives identification RT.

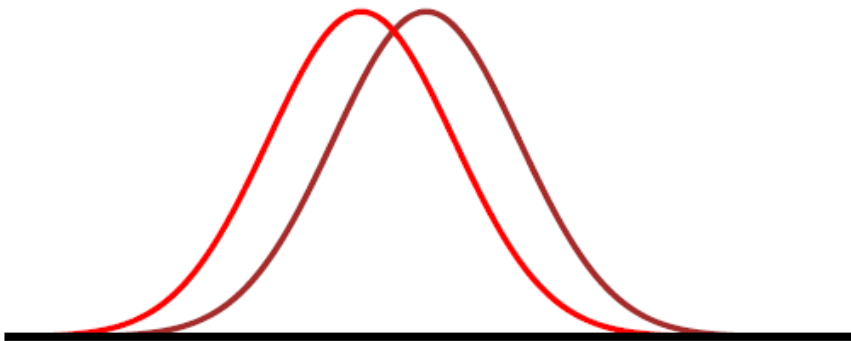


Berry, Shanks, & Henson, *JEP:LMC*, 2008
Berry, Shanks, & Henson, *TICS*, 2008
Shanks & Perruchet, *PB&R*, 2002
Shanks, Wilkinson, & Channon, *JEP:LMC*, 2003

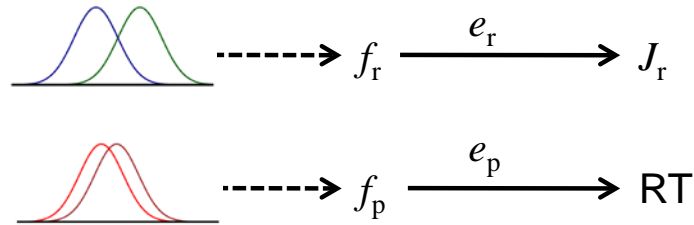
A theoretical framework



These are both special cases of a more general model in which the signals are correlated.



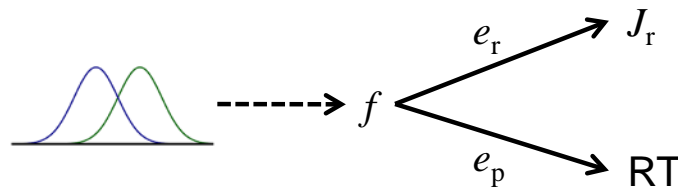
Independence Model



w (correlation between the values of f sampled for recognition and priming) = 0

μ (separation of distributions) can differ for recognition and priming

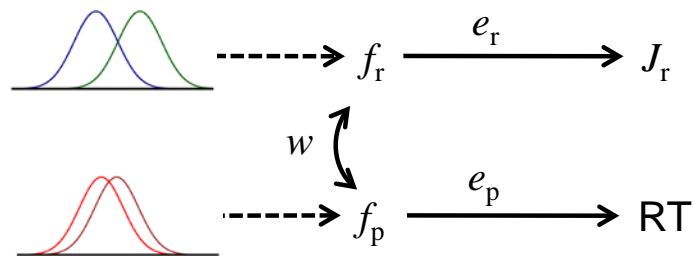
Single-system Model



$w = 1$

μ (recog) = μ (priming)

General Model



w is free to vary

μ is free to vary between recognition and priming

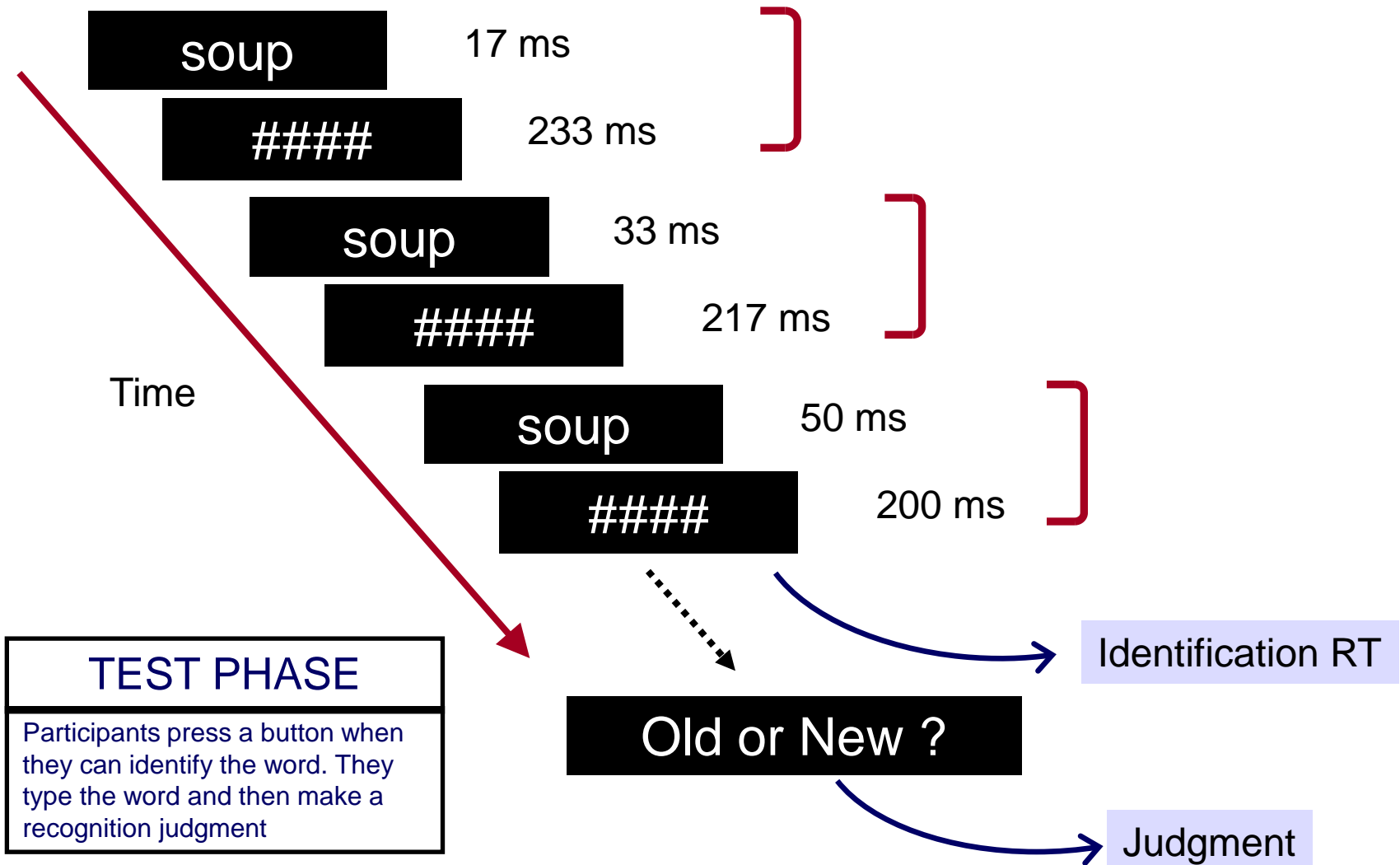
Model selection

Formal model-fitting methods are ideally suited to decide between models that vary in flexibility (number of parameters)

Although the general model will always fit better than restricted ones, model fit statistics (e.g., Akaike Information Criterion, AIC) penalize models for excessive parameters

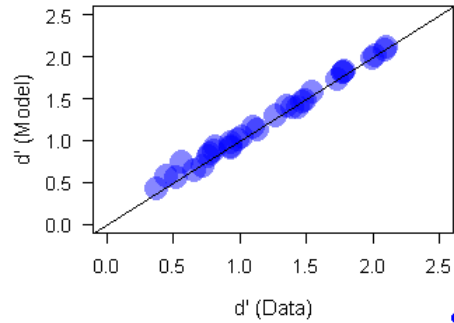
Hence a restricted model may be preferred (= lower AIC)

The models were fit to the group and individual participant data using maximum likelihood parameter estimation

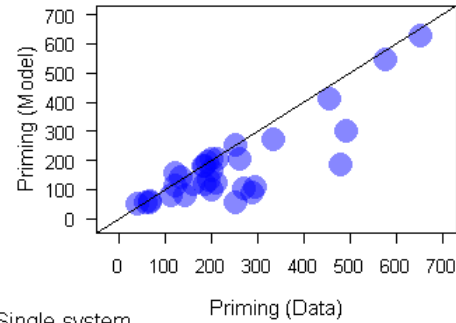


- Exp 1: old/new
- Exp 2: 1=sure new, ..., 6=sure old
- Exp 3: old (Remember/Know/Guess)/new

Exp 1 -- Recognition

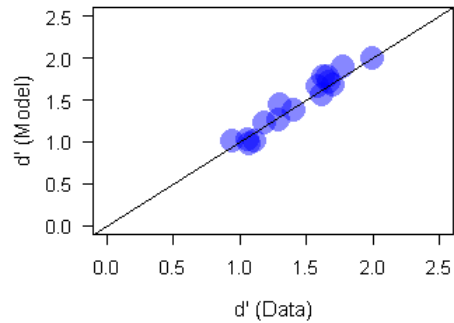


Exp 1 -- Priming

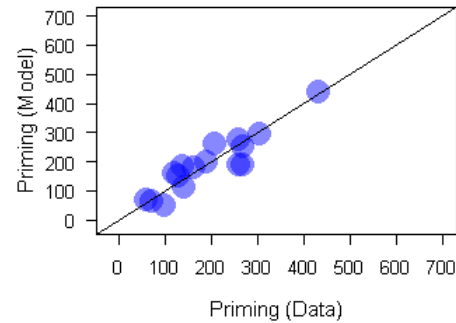


- Single-system
- Independence
- General

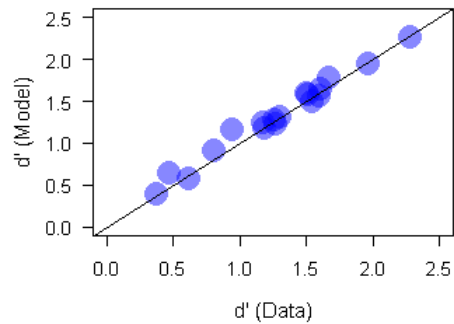
Exp 2 -- Recognition



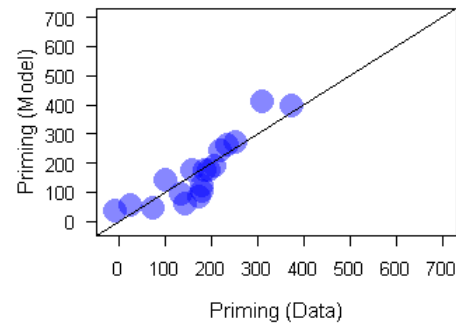
Exp 2 -- Priming



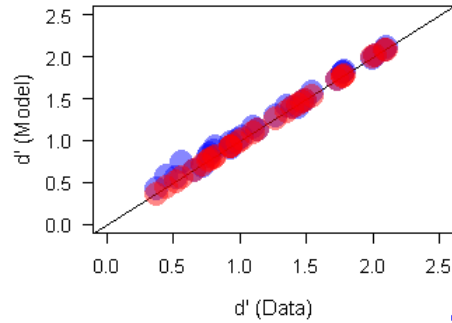
Exp 3 -- Recognition



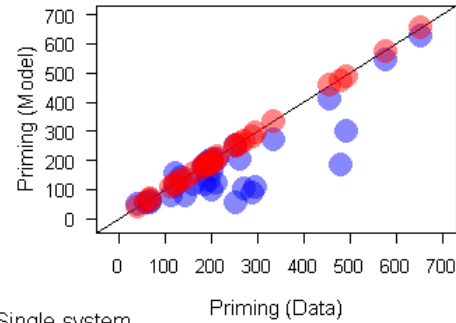
Exp 3 -- Priming



Exp 1 -- Recognition

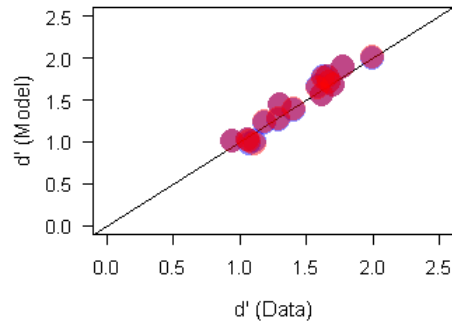


Exp 1 -- Priming

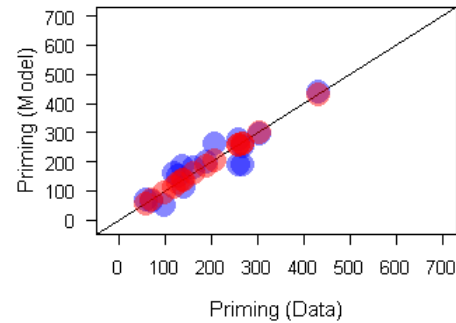


- Single-system
- Independence
- General

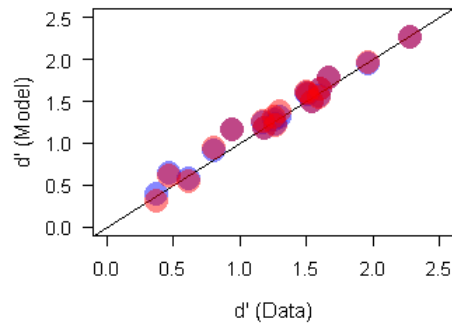
Exp 2 -- Recognition



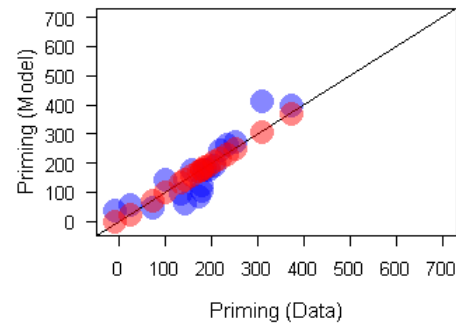
Exp 2 -- Priming



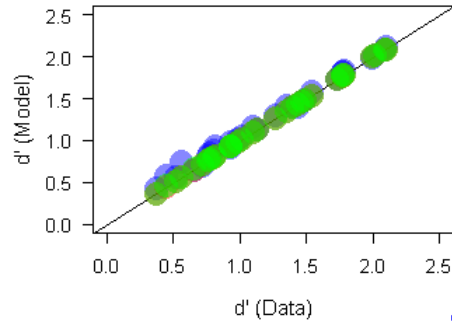
Exp 3 -- Recognition



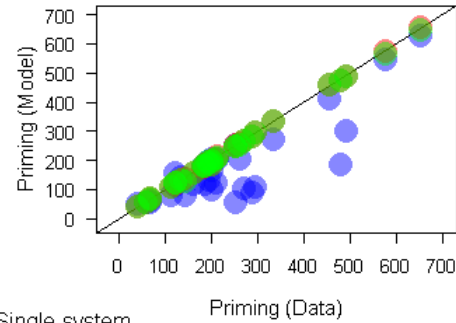
Exp 3 -- Priming



Exp 1 -- Recognition

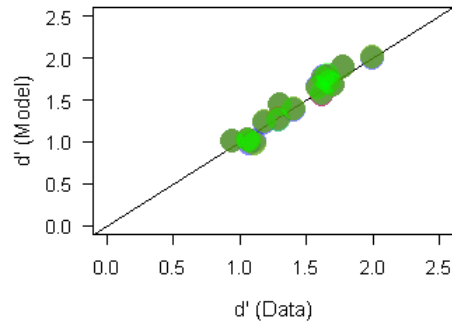


Exp 1 -- Priming

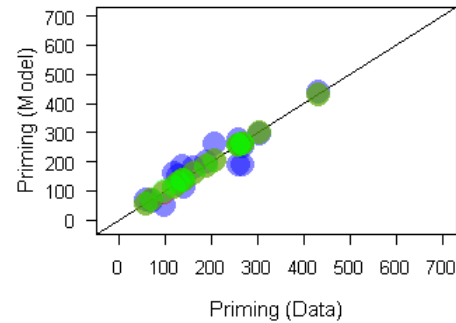


- Single-system
- Independence
- General

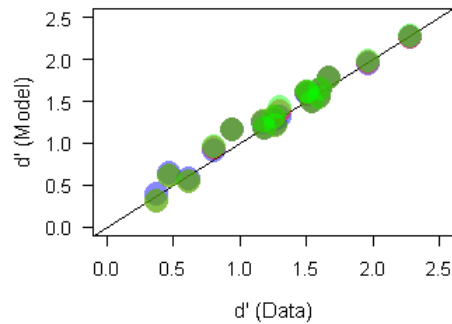
Exp 2 -- Recognition



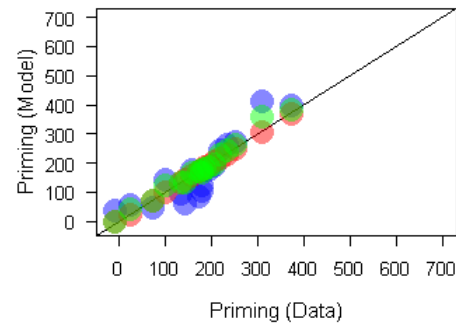
Exp 2 -- Priming



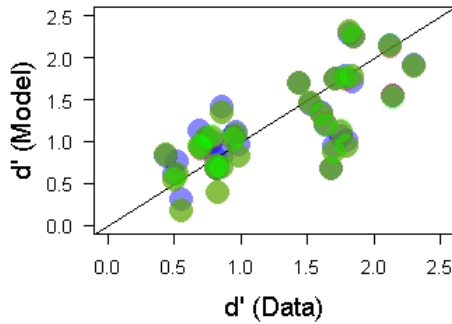
Exp 3 -- Recognition



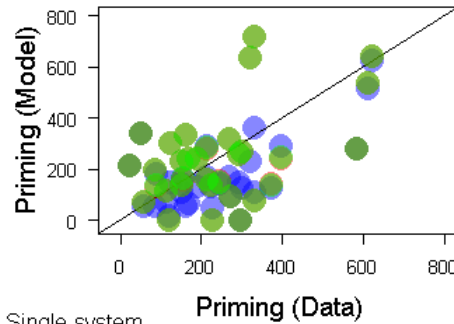
Exp 3 -- Priming



Exp 1 -- Recognition

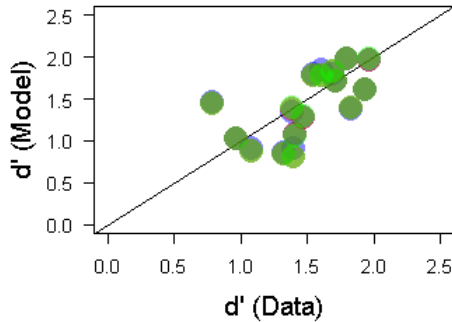


Exp 1 -- Priming

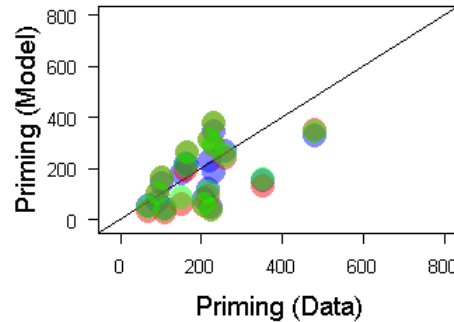


- Single-system
- Independence
- General

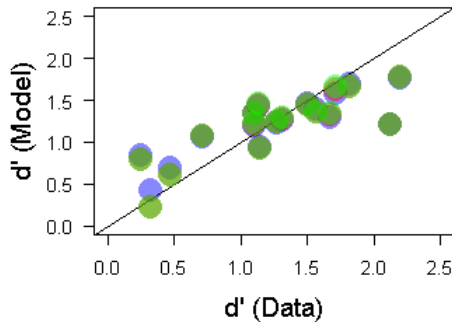
Exp 2 -- Recognition



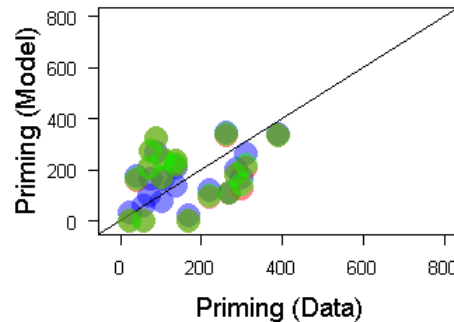
Exp 2 -- Priming



Exp 3 -- Recognition



Exp 3 -- Priming



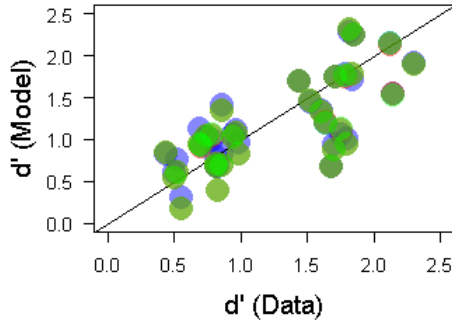
Priming:

$$R^2 \text{ (single-system)} = .35$$

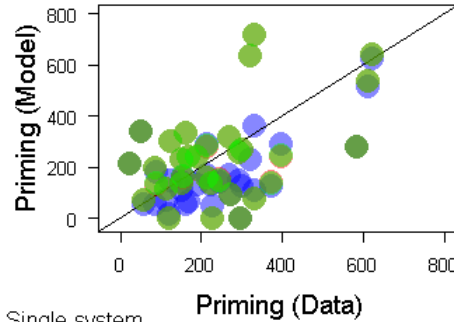
$$R^2 \text{ (independence)} = .19$$

$$R^2 \text{ (general)} = .20$$

Exp 1 -- Recognition

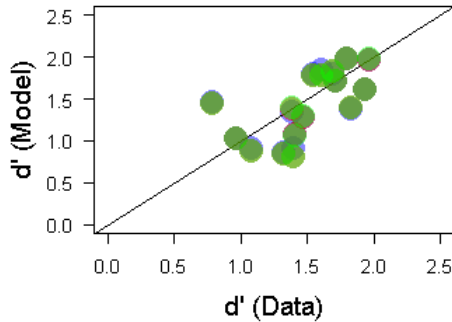


Exp 1 -- Priming

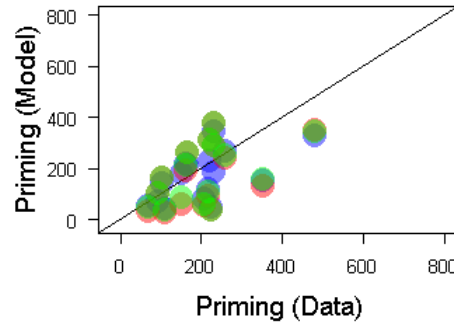


● Single-system
● Independence
● General

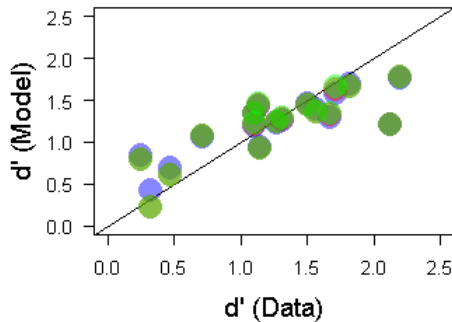
Exp 2 -- Recognition



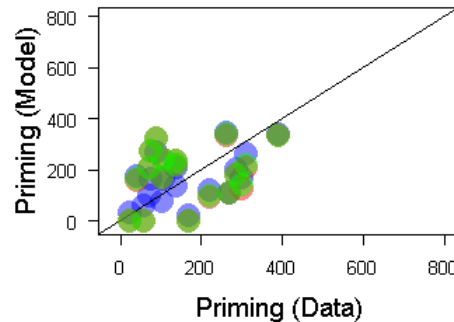
Exp 2 -- Priming



Exp 3 -- Recognition



Exp 3 -- Priming



	Single	Indep	General
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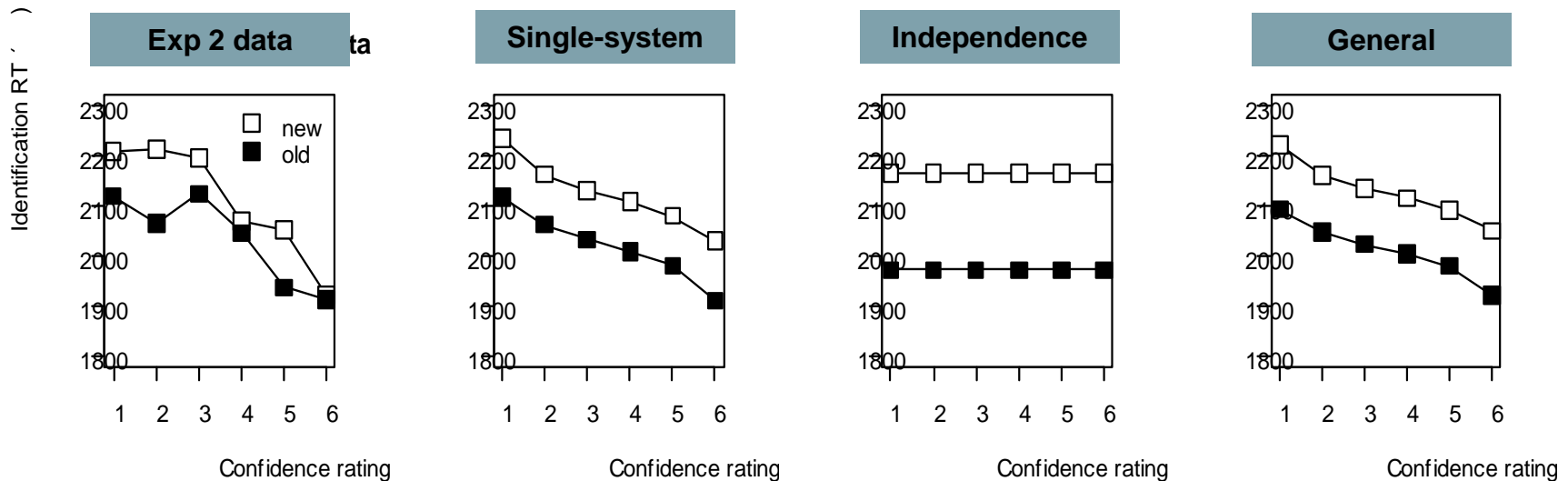
Experiment 1			
μ_{recog}	1.25	1.21	1.21
μ_{priming}	$= \mu_{\text{recog}}$	1.70	1.70
w	$= 1$	$= 0$	0.60
AIC	150053	150114	150101

Experiment 2			
μ_{recog}	1.47	1.47	1.47
μ_{priming}	$= \mu_{\text{recog}}$	1.50	1.50
w	$= 1$	$= 0$	0.78
AIC	84187	84261	84206

Experiment 3			
μ_{recog}	1.33	1.33	1.33
μ_{priming}	$= \mu_{\text{recog}}$	1.34	1.38
w	$= 1$	$= 0$	0.75
AIC	60658	60714	60679

Single-system model: Recognition judgments will generally be related to identification RTs

Independence model: Recognition judgments will generally be uncorrelated with identification RTs

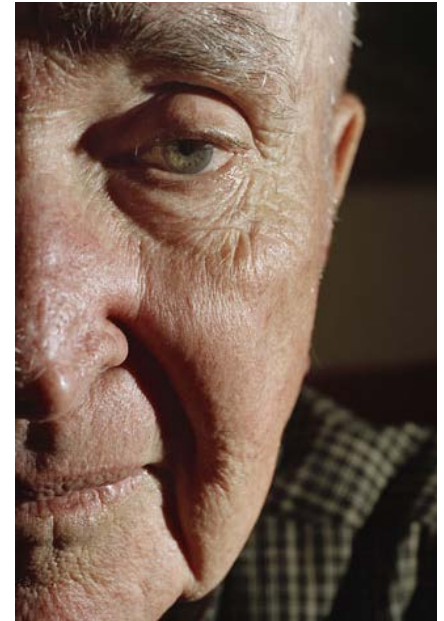


Priming and recognition in amnesia

Using a CID-R paradigm at test, Conroy, Hopkins, & Squire (2005) showed that

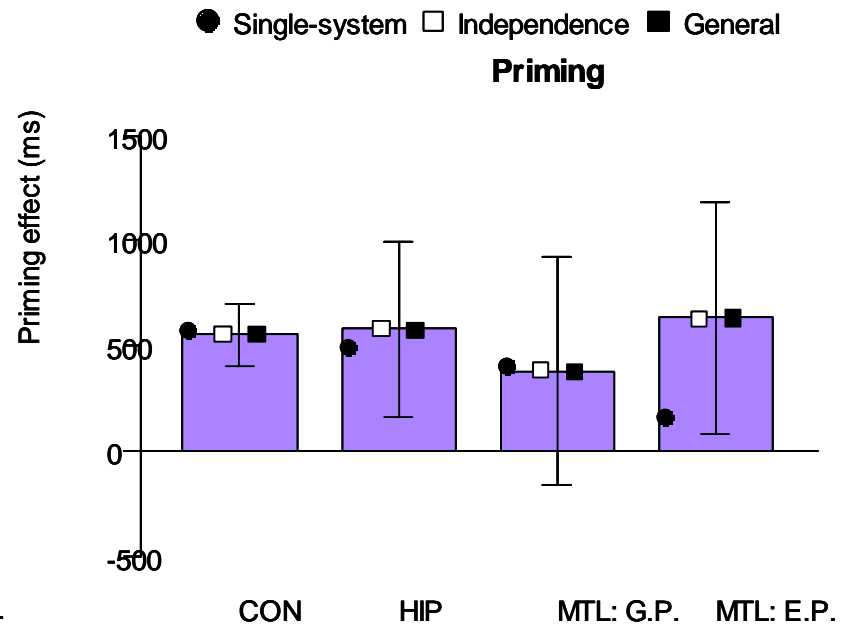
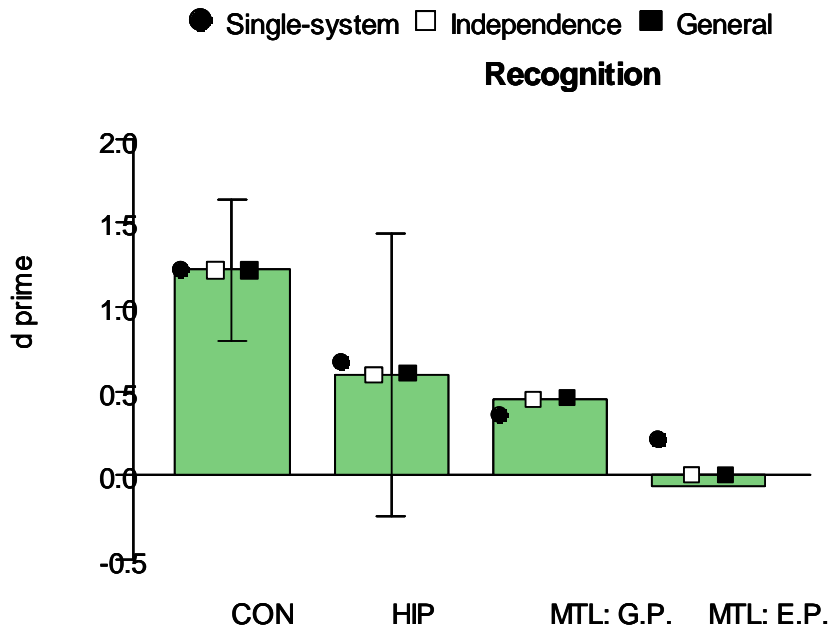
- amnesic individuals including E.P. are impaired in recognition, and yet
- show spared priming

Taken as evidence that the memory source driving priming is different to that driving recognition, i.e., multiple systems



E.P.

Conroy, Hopkins, & Squire (2005) – Results and modeling



	Single	Indep	General
CON	11624	11633	11634
HIP	4452	4454	4455
G.P.	1468	1478	1470
E.P.	1487	1485	1484

Conclusions

- Formal modelling can offer a powerful additional tool for addressing questions about the organization of memory
- By being an extension of SDT, the general framework inherits a long history of important support and theoretical insight
- When specific models are constructed within the general framework, a single-system model is preferred
- The single-system model fits the dissociation observed in amnesia surprisingly well
- Next stage:
 - Can priming occur in the absence of recognition?
 - Exploring other models within the general framework (eg Yonelinas' dual-process model)
 - Application to aging and Korsakoff's amnesia
 - Extension to source memory