



Universitätsklinikum  
Hamburg-Eppendorf

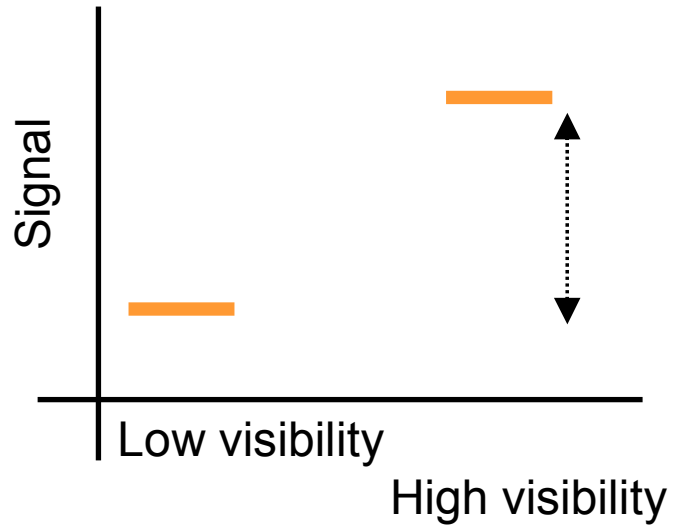
# Advanced Designs and Models

SPM-Kurs 2011

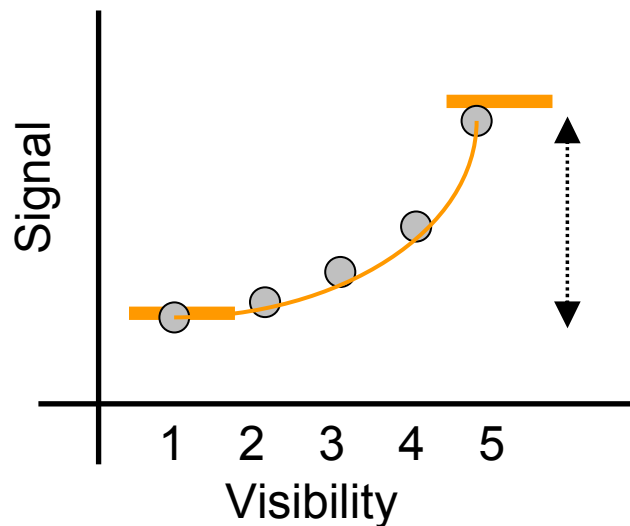
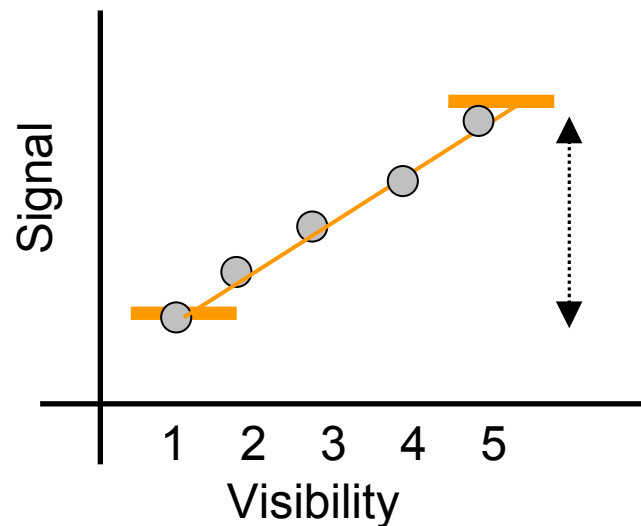
Jan Peters  
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Neuroimage Nord  
Institut für Systemische Neurowissenschaften

# Kategorisches Design

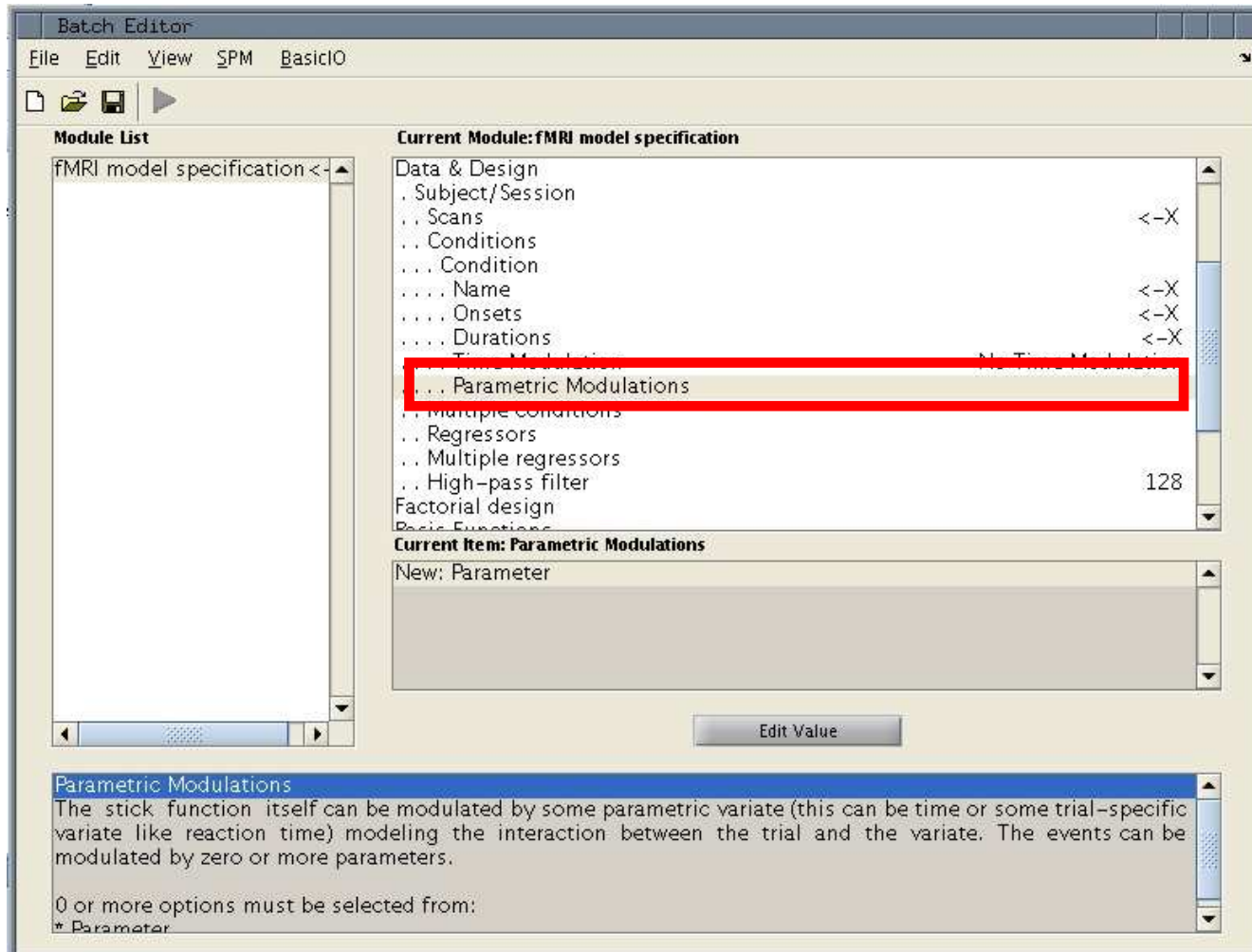


# Parametrisches Design: Bestimmung der Stimulus-Antwort-Funktion

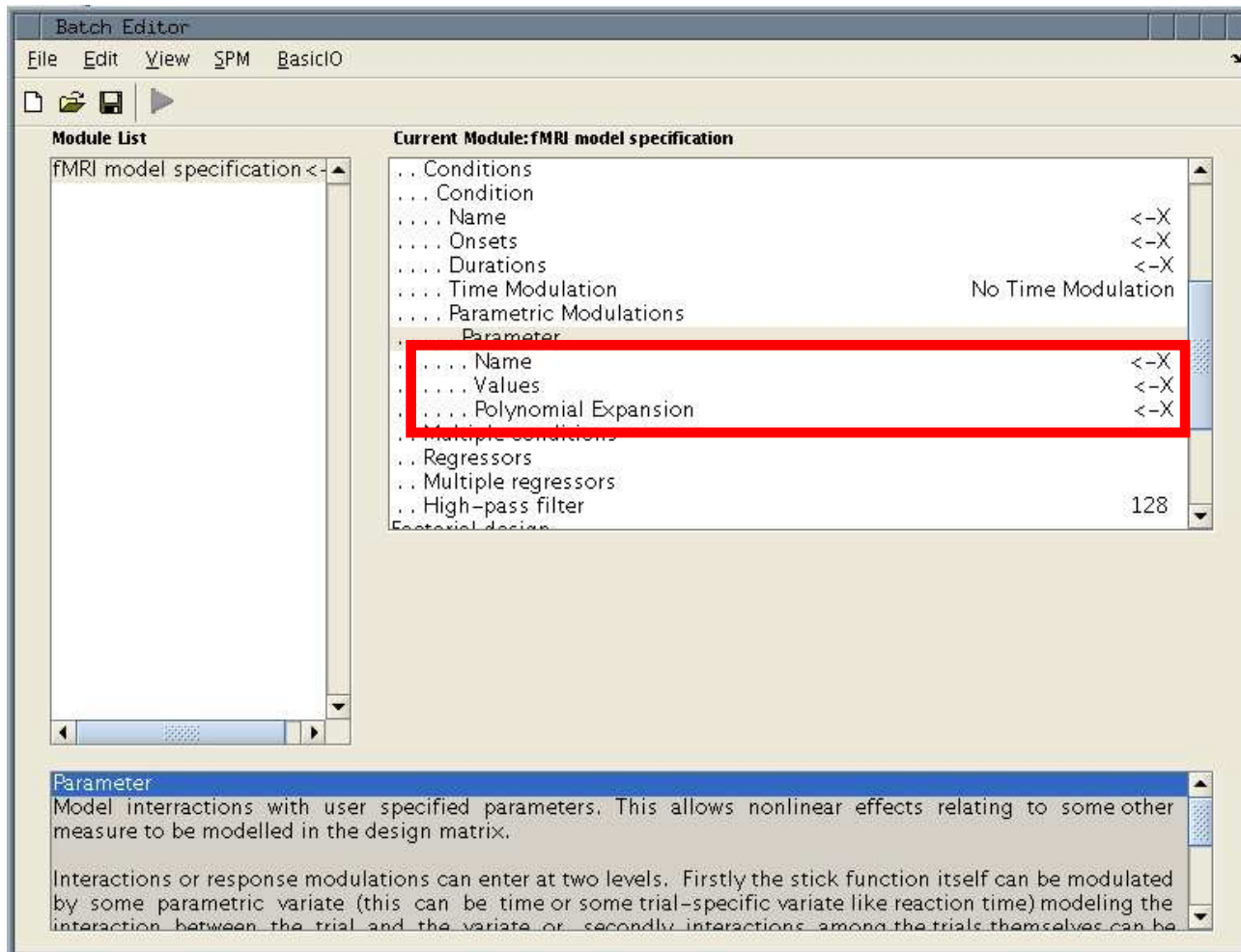


Im kategorischen Design:  
verschiedene Stimulus-  
Antwort-Funktionen werden  
nicht unterschieden.

# Parametric Modulation



# Parametric Modulation



Name

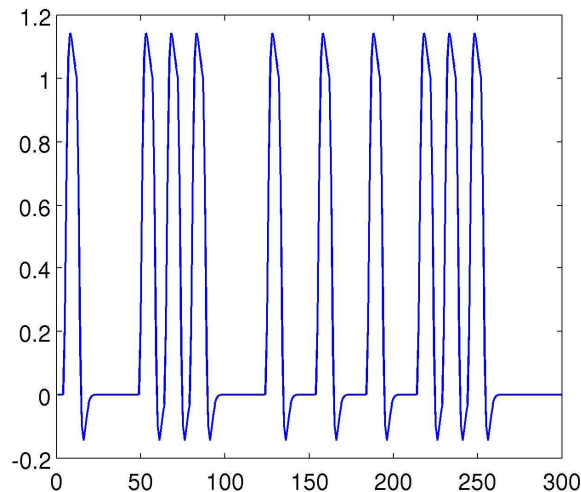
Values

Polynomial Exp.:  
1-linear, 2-quadratic,...

# Parametrische Designs

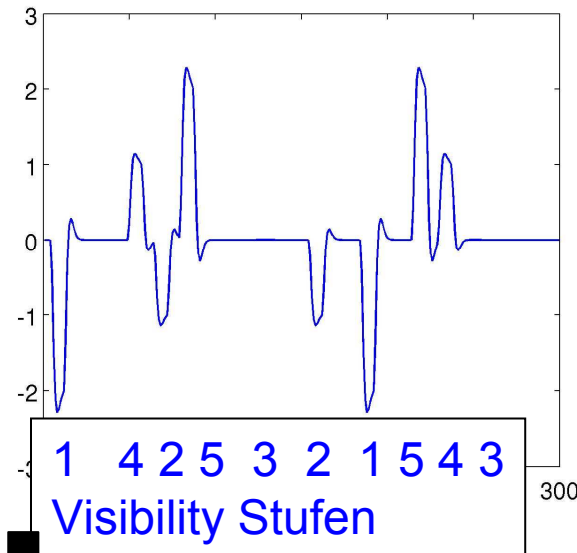
Zusätzlicher Regressor: Modulation der Stick-Funktion mit einem Trial-by-Trial Parameter (Mean-corrected), z.B. Bildsichtbarkeit:

Onset-Regressor (box car):



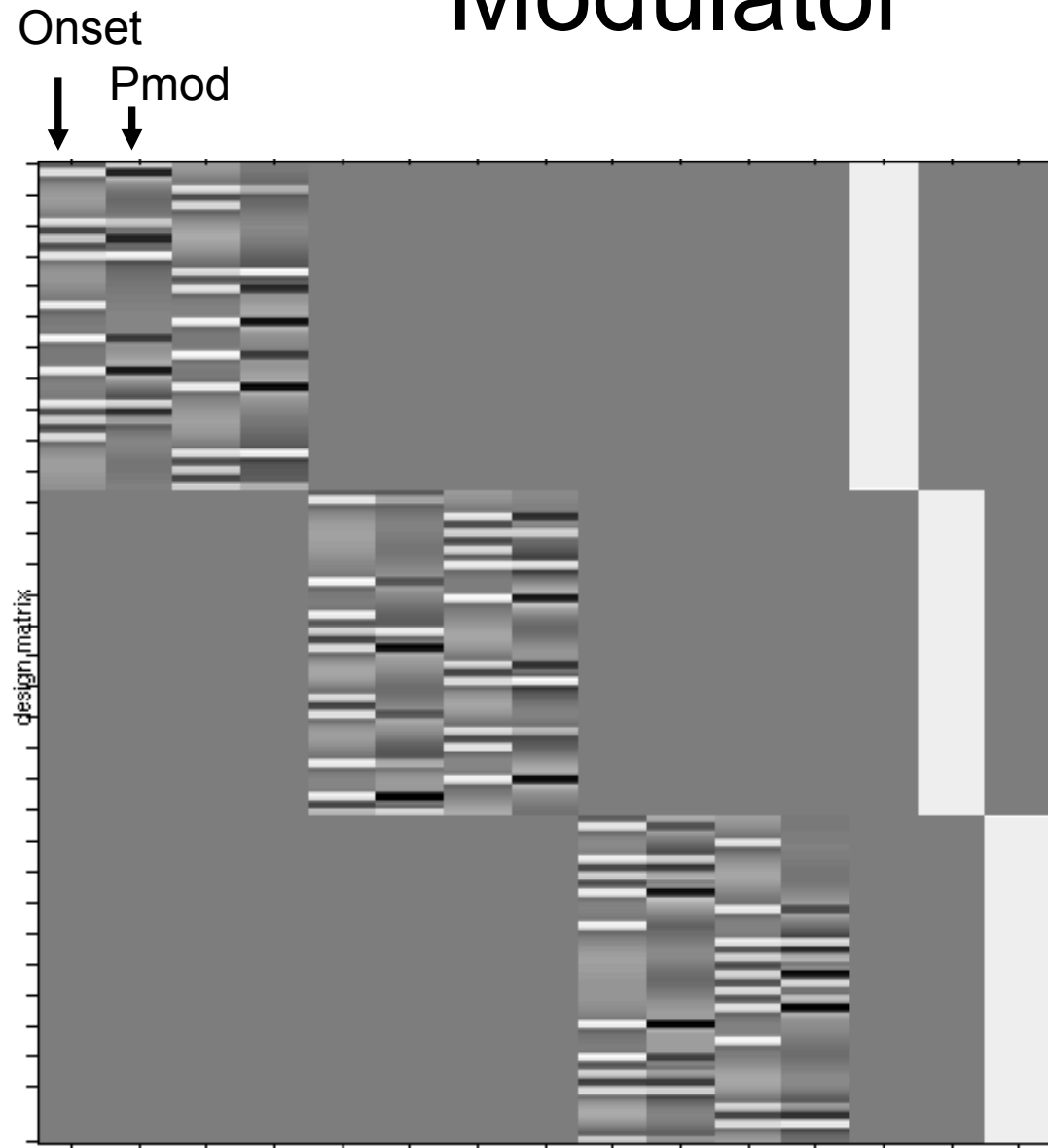
Mittelwert der Bedingung

Parametrischer Regressor: Visibility (linear)

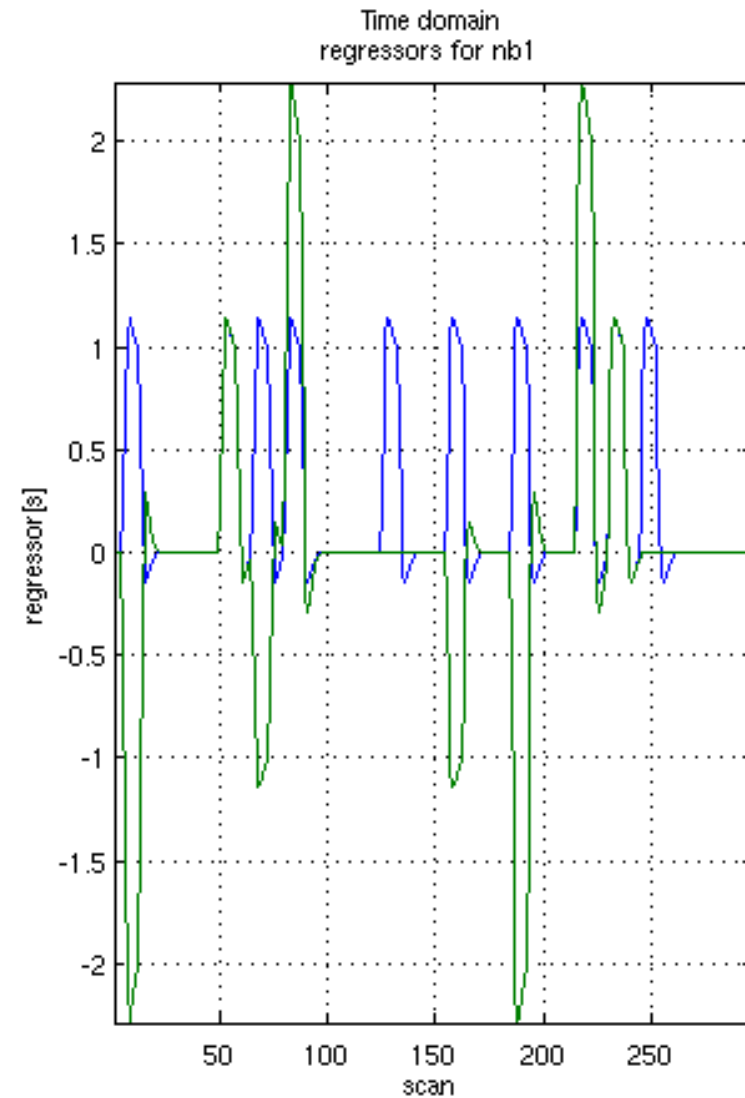
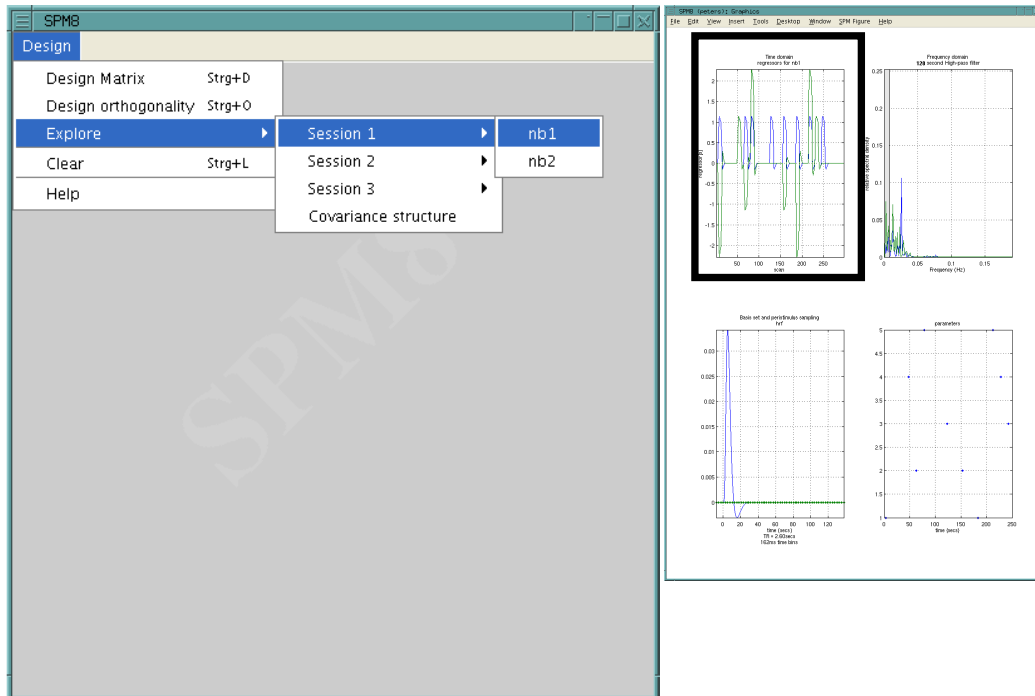


Variabilität um den Mittelwert, die linear mit der Bildsichtbarkeit zusammenhängt.

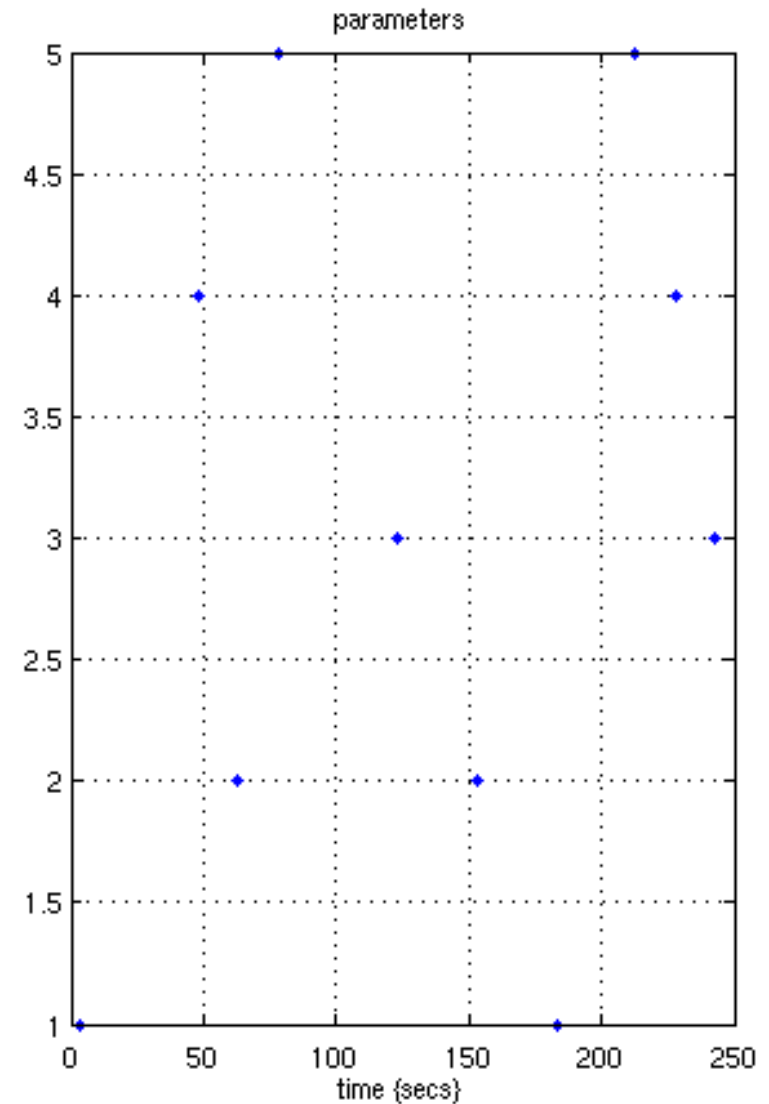
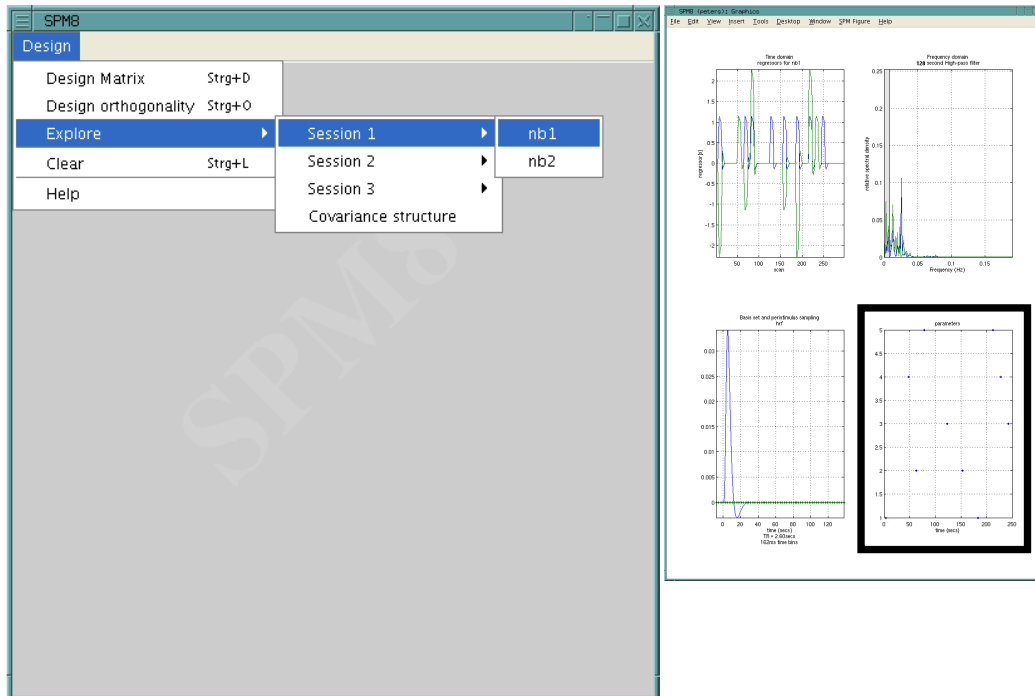
# Design Matrix mit parametrischem Modulator



# Parametrische Regressoren



# Parametrische Regressoren

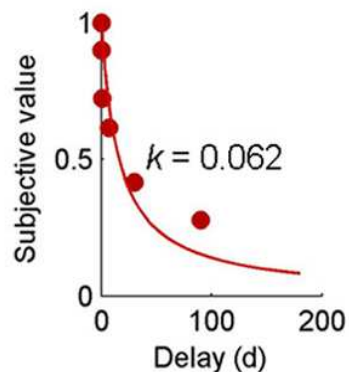
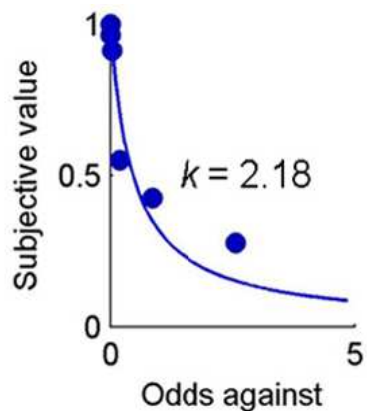


# Parametrische Designs

- Voraussetzung: Trial-by-trial Maß
- Anwendung parametrischer Designs:
  - Endogene Faktoren:
    - Subjektive Ratings des Probanden: „memory confidence“, Schmerzempfindung, ...
    - Computationale Modelle: „Prediction errors“, „Values“, ...
    - Reaktionszeiten
    - Blickbewegungsmuster
  - Exogene Faktoren:
    - „objektive“ Bildsichtbarkeit, Arbeitsgedächtnisload, ...
    - Zeit

# Beispiel: Subjektive Belohnungswerte im Ventralen Striatum

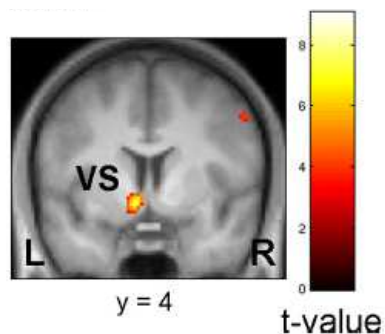
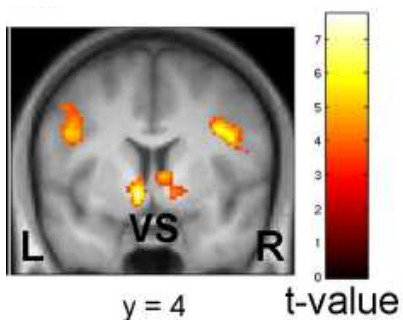
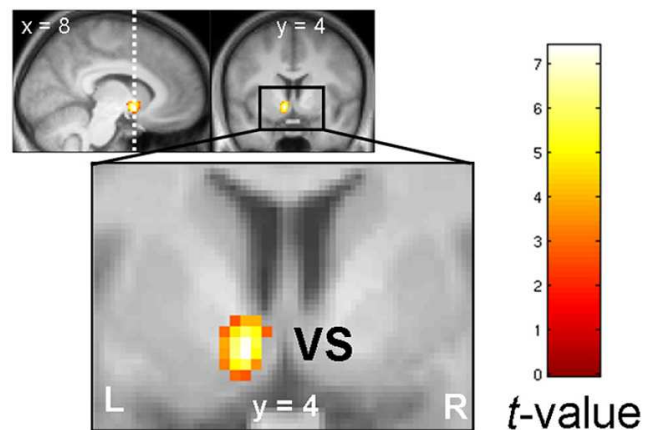
Model-basierte „values“:



Subjektiver Wert:  
Probabilistische Belohnung

Subjektiver Wert:  
Zeitverzögerte Belohnung

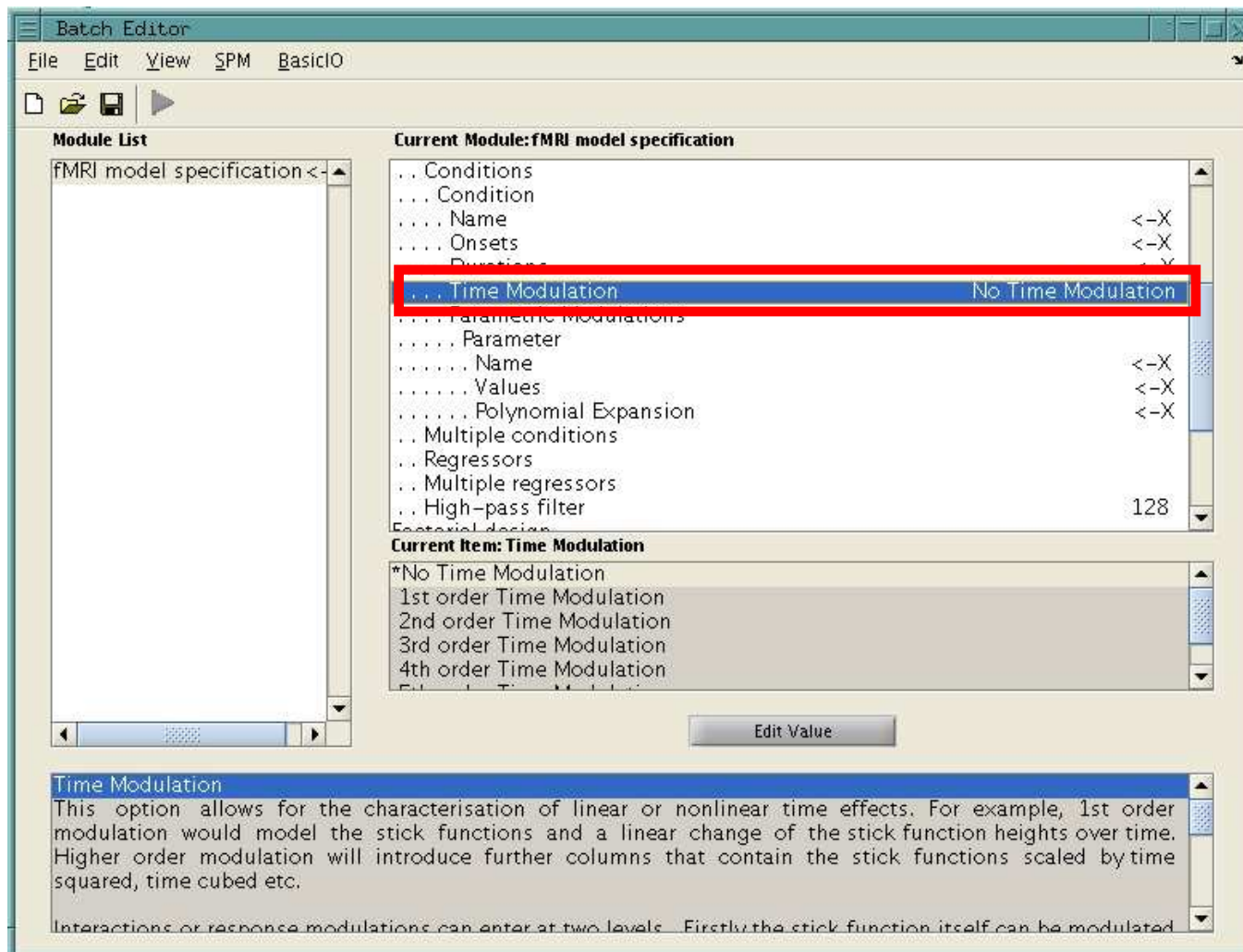
Subjektiver Wert: Conjunction



# Time modulation

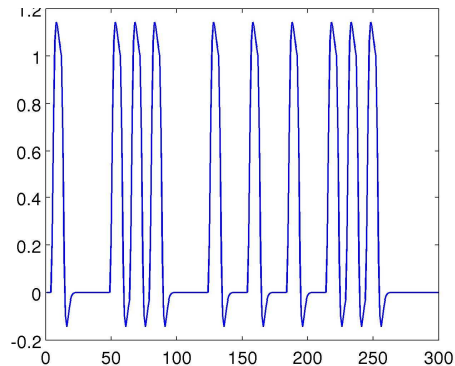
- „Sonderfall“ der parametrischen Modulation: Zeit
- Amplitude des Signals wird in Abhängigkeit der Zeit (*Nummer des Scans*) modelliert: linear, quadratisch usw.
- Anwendung z.B. Lerneffekte in frühen aber nicht in späteren Trials

# Time modulation



# Time modulation

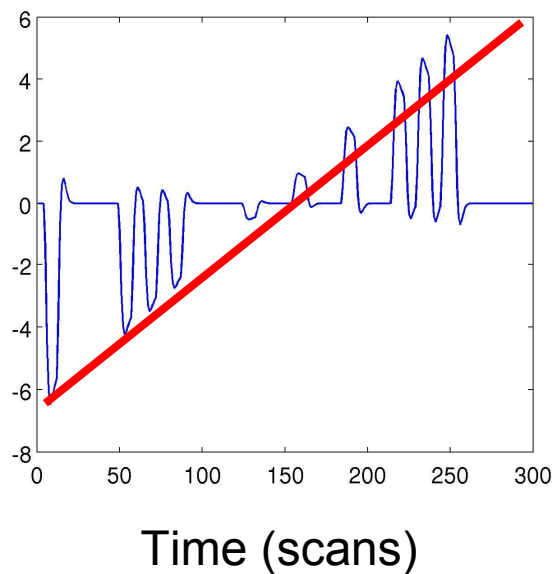
Onset-Regressor (box car):



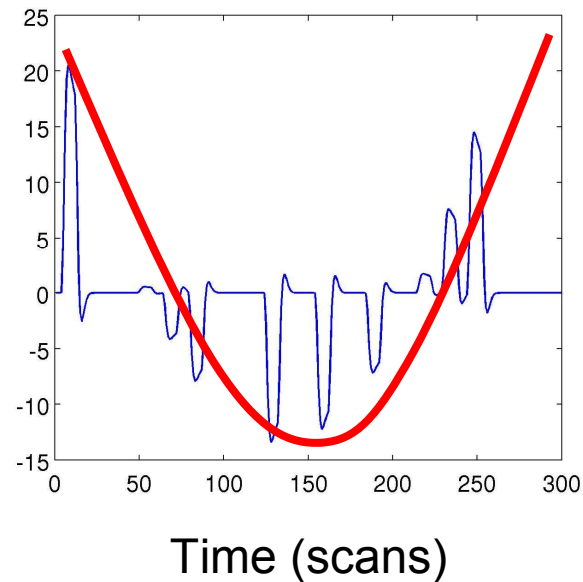
## 1. Main effect:

- Box car
- Event-related

Linear effect of time:



Quadratic effect of time:



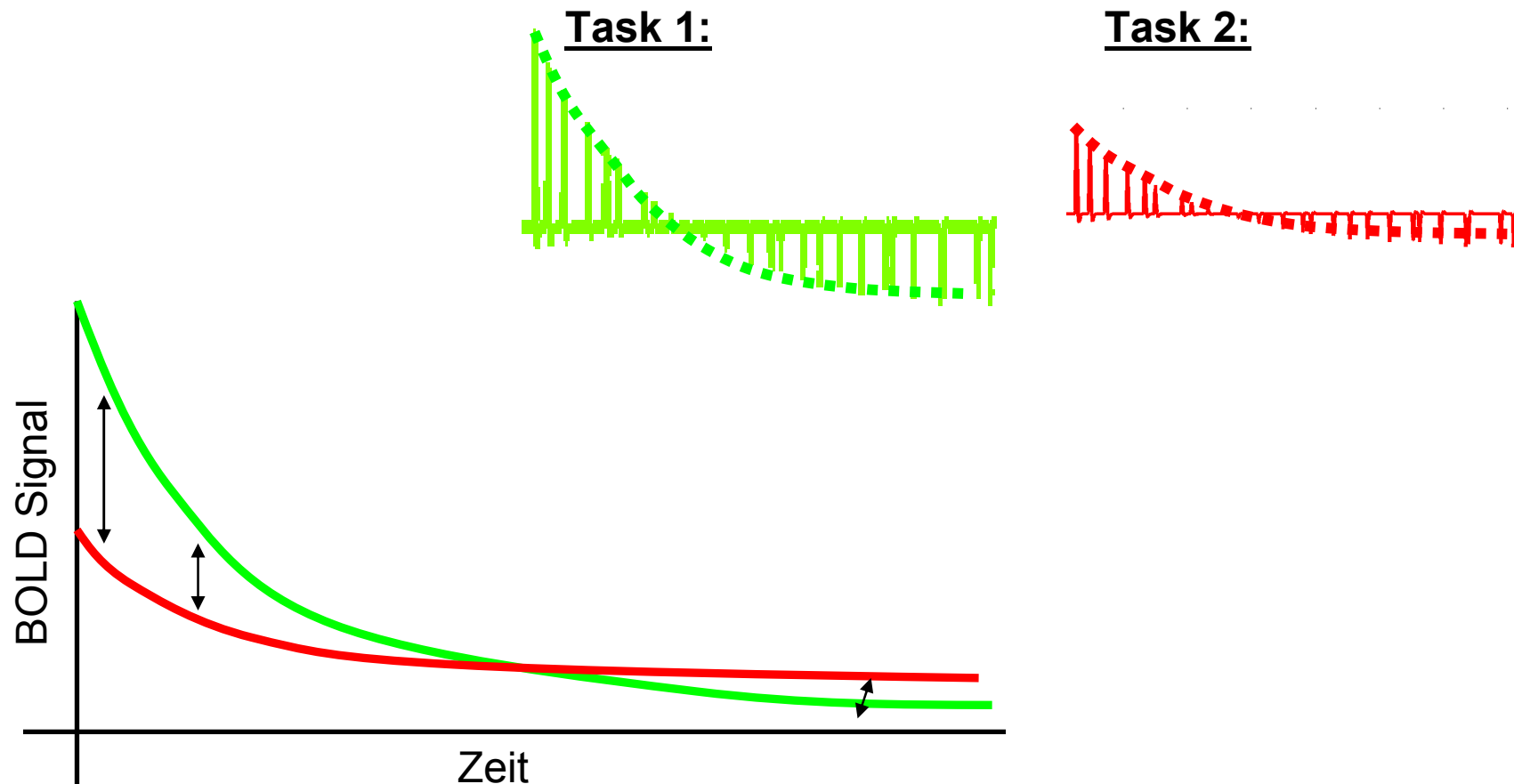
## 2. Expansion

ME + linear /  
quadratic change

→ Als zusätzliche Spalte in der Design Matrix!

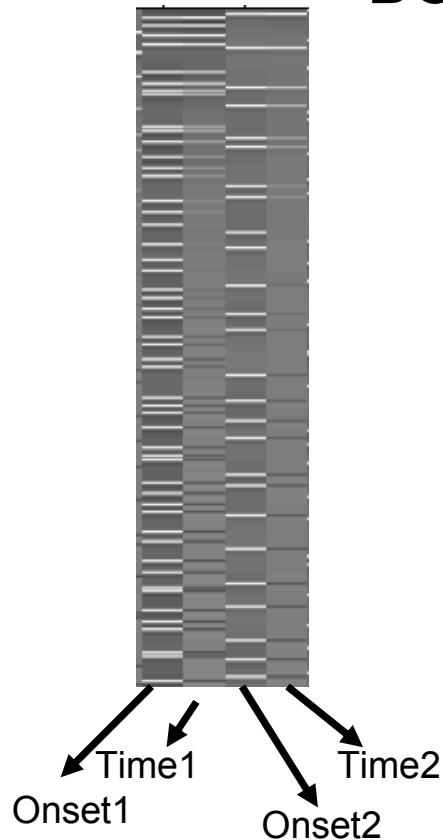
# Differentielle Time x Condition Interaktion

→ Größerer Zeiteffekt bei Lerntask vs. Kontrolltask



# Differentielle Time x Condition Interaktion

Stärkerer negativer Zusammenhang zwischen  
BOLD Amplitude und Zeit in Bedingung 1 vs. 2



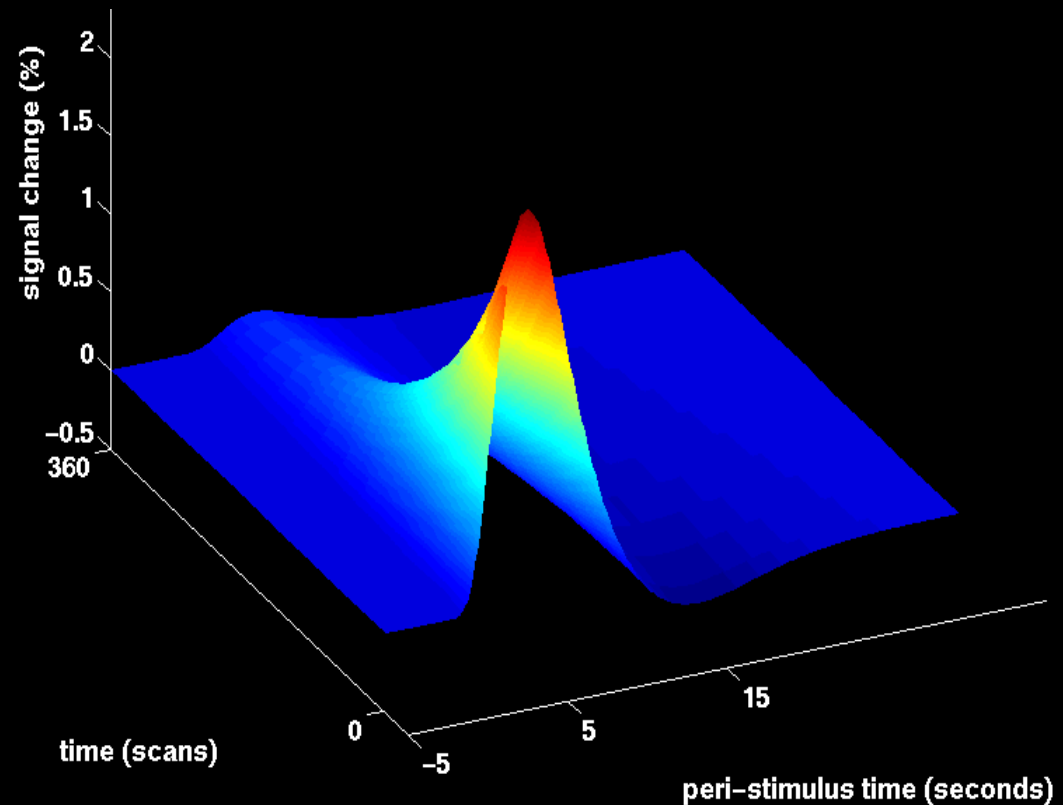
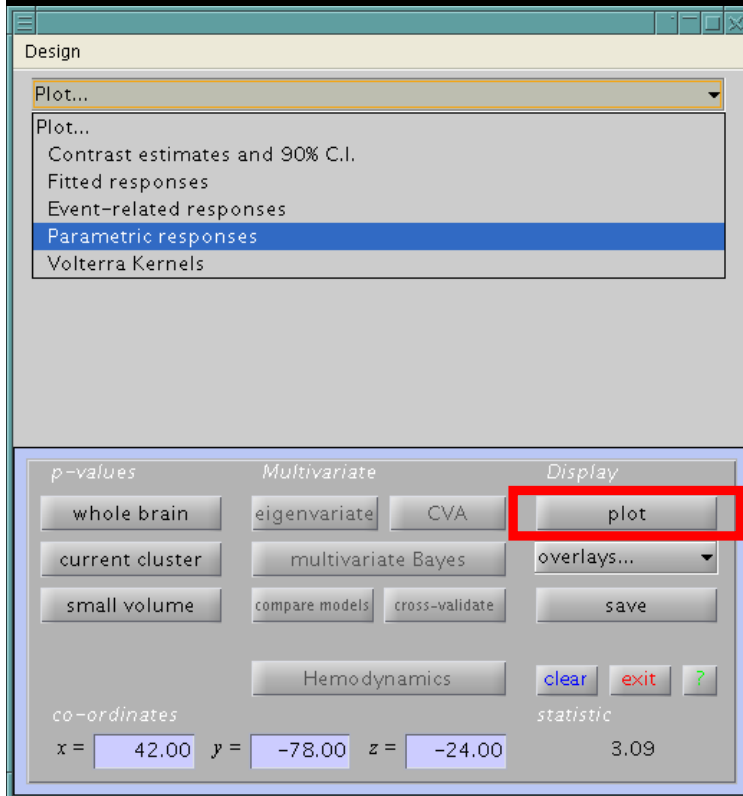
# Visualization: parametric + time modulation

1st level:

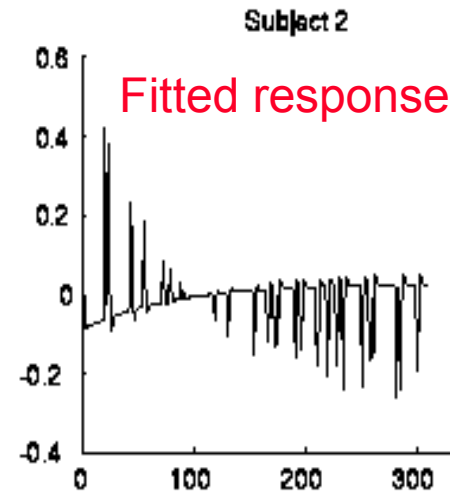
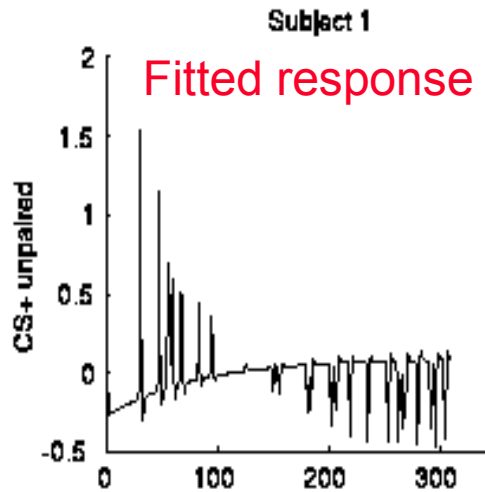
→ Plot → Parametric Responses

2nd level:

RFX-plot (Gläscher, 2009)



# Beispiel: Rapid habituation of amygdala response



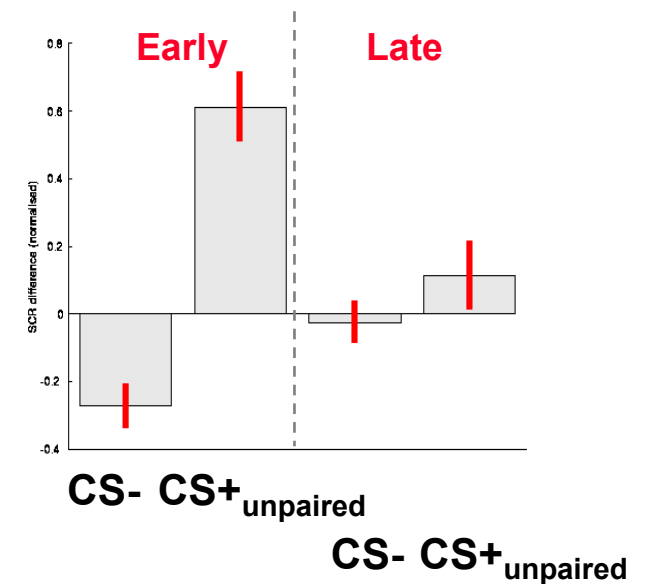
## Interaction: SCR early versus late



y = 3 mm



Büchel et al., (1998), Neuron

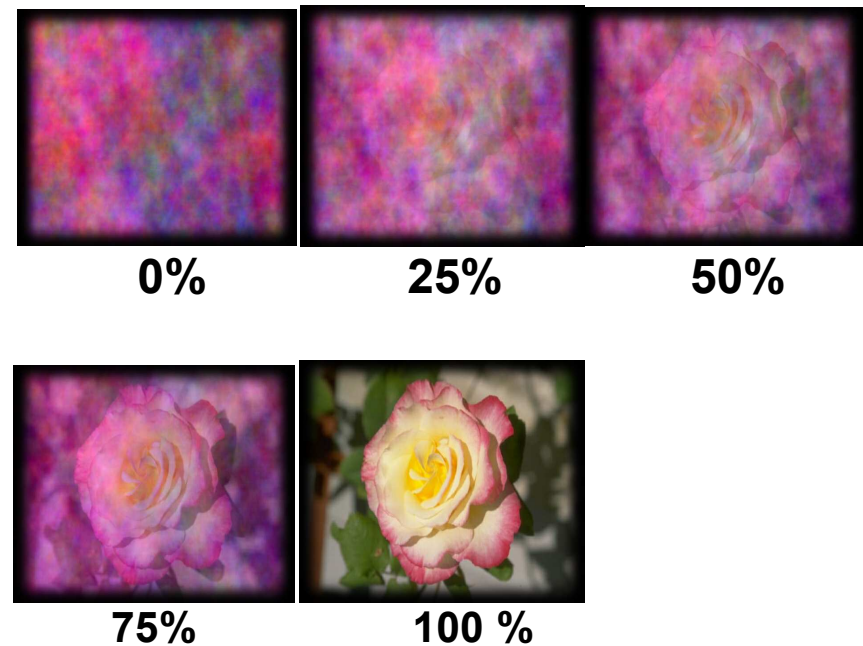


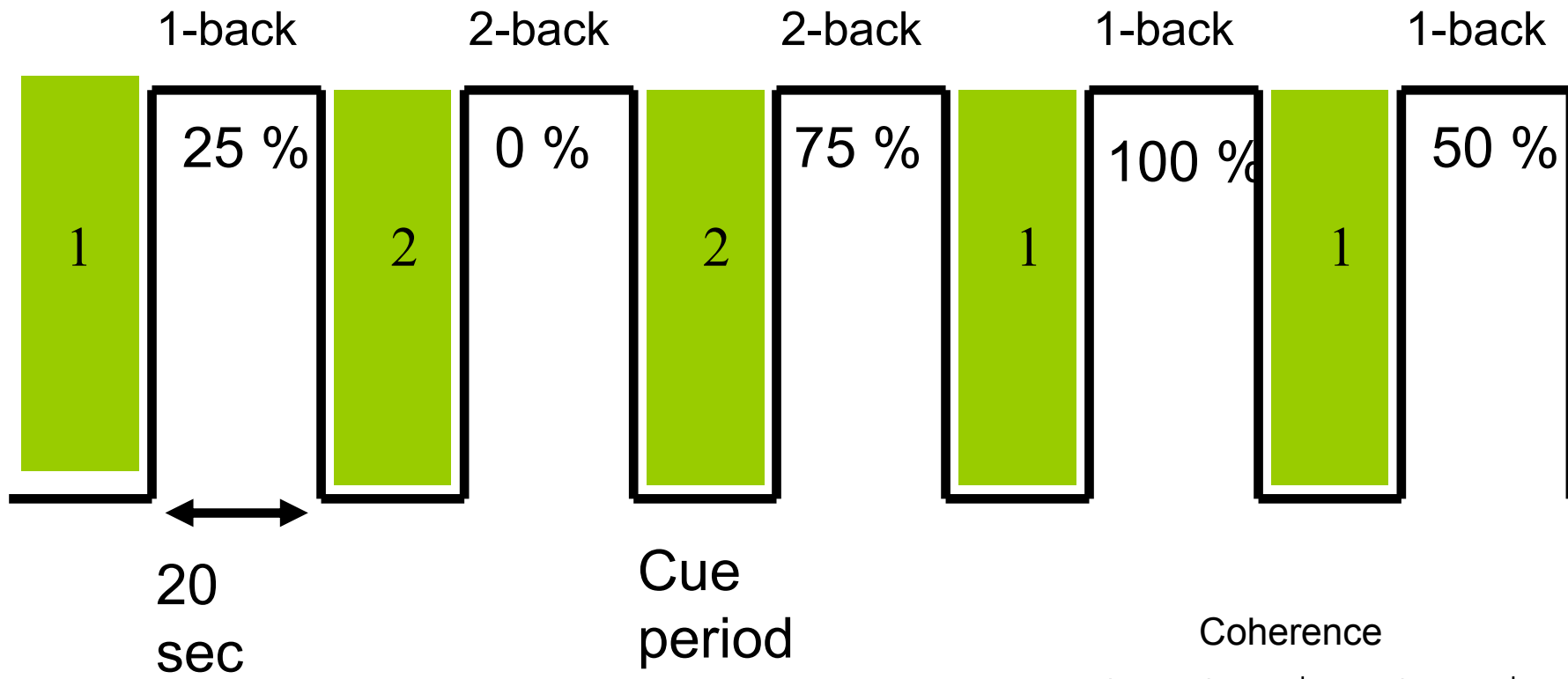
# Beispielstudie:

## Visuelle Verarbeitung und kognitiver "Load"

- Working memory task („cognitive load“)
- 0, 25, 50, 75 & 100 % Image phase coherence (~Visibility)
- n-back working memory task
  - 1 - back
  - 2 - back
- Parametric factorial design
- n = 14

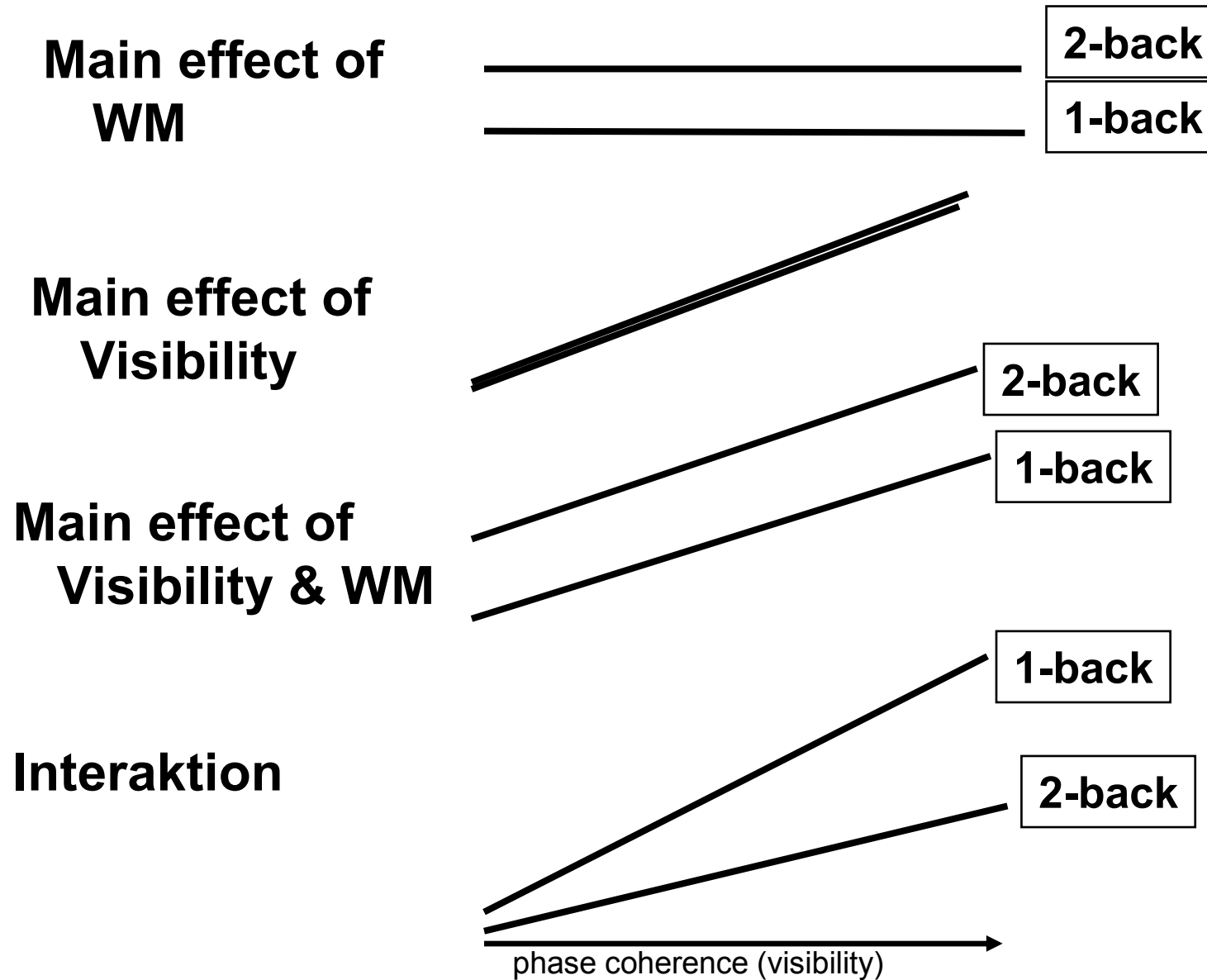
		Coherence				
		0%	25%	50%	75%	100%
N-back	2-back					
	1-back					





		Coherence				
		0%	25%	50%	75%	100%
N-back	1-back					
	2-back					

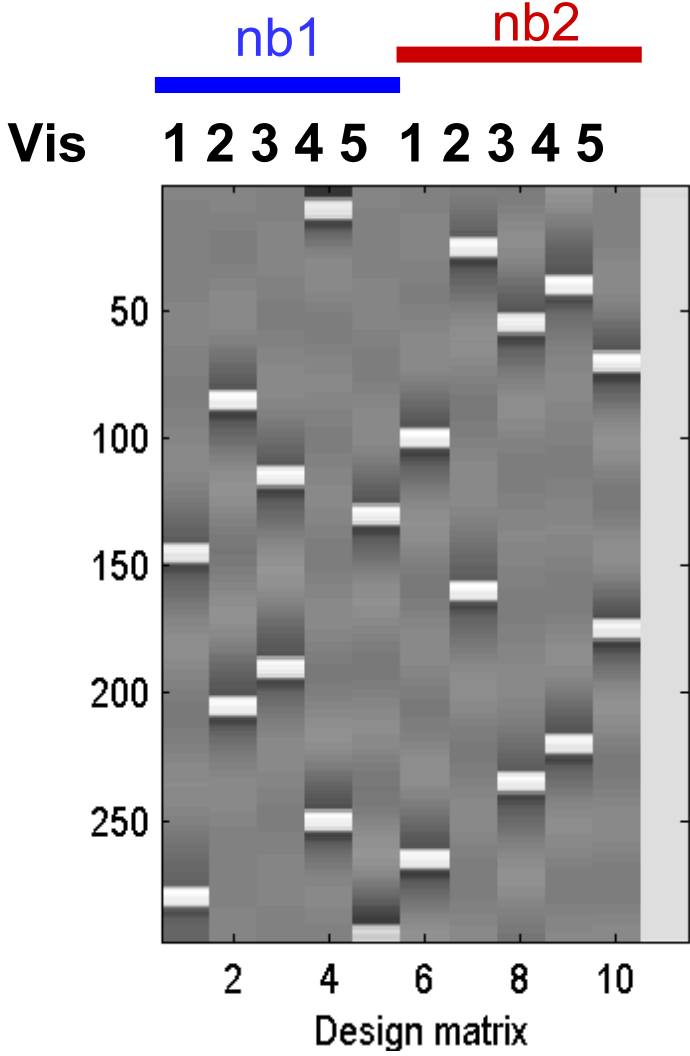
# Prototypical Responses



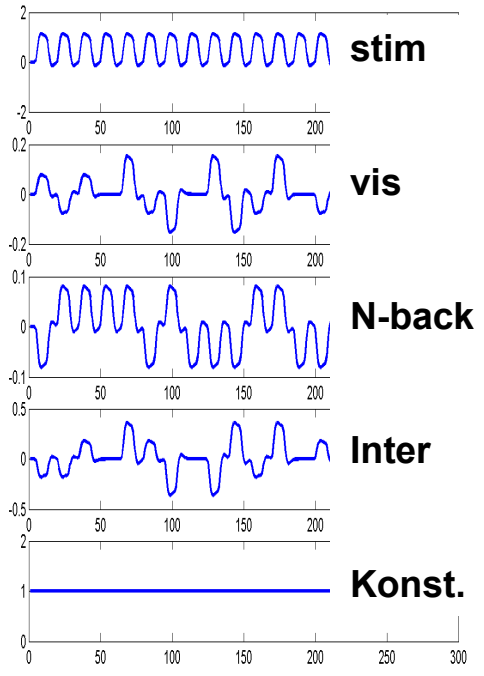
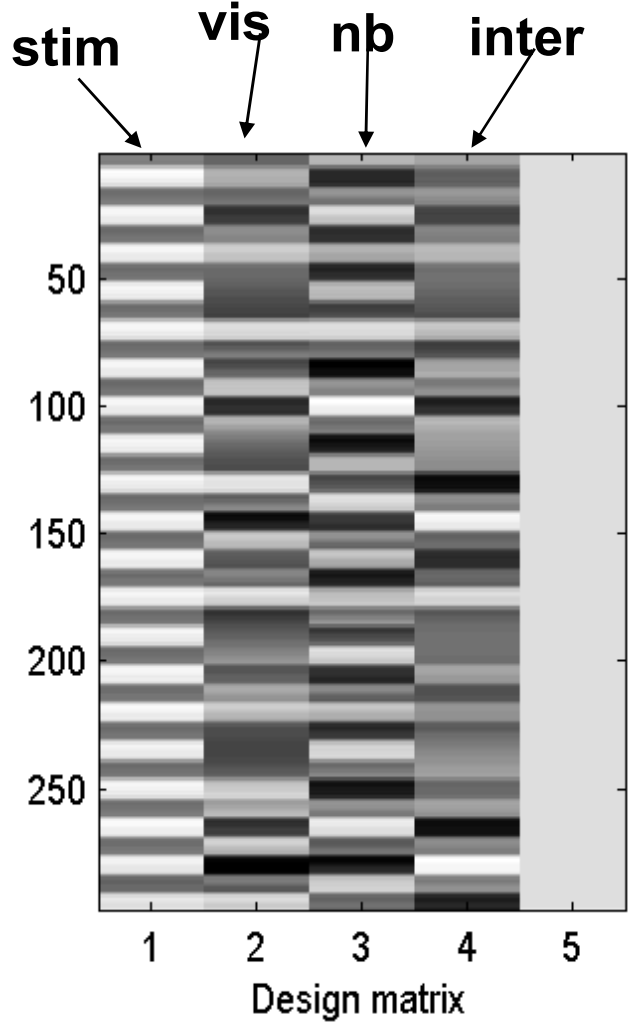
# Unterschiedliche Modelle für das gleiche Design

- Kategoriales Modell:
  - 1 Regressor pro Zelle im faktoriellen Design
  - $\rightarrow 2$  (nback)  $\times$  5 (visibility) = 10 Bedingungs-Regressoren
- Parametrisches Modell:
  - 1 Regressor für den Trial-Onset (Stimulus)
  - 3 parametrische Modulatoren:
    - Visibility (1,2,3,4,5), n-back (1,2)
    - Interaktionsterm: Visibility  $\times$  n-back

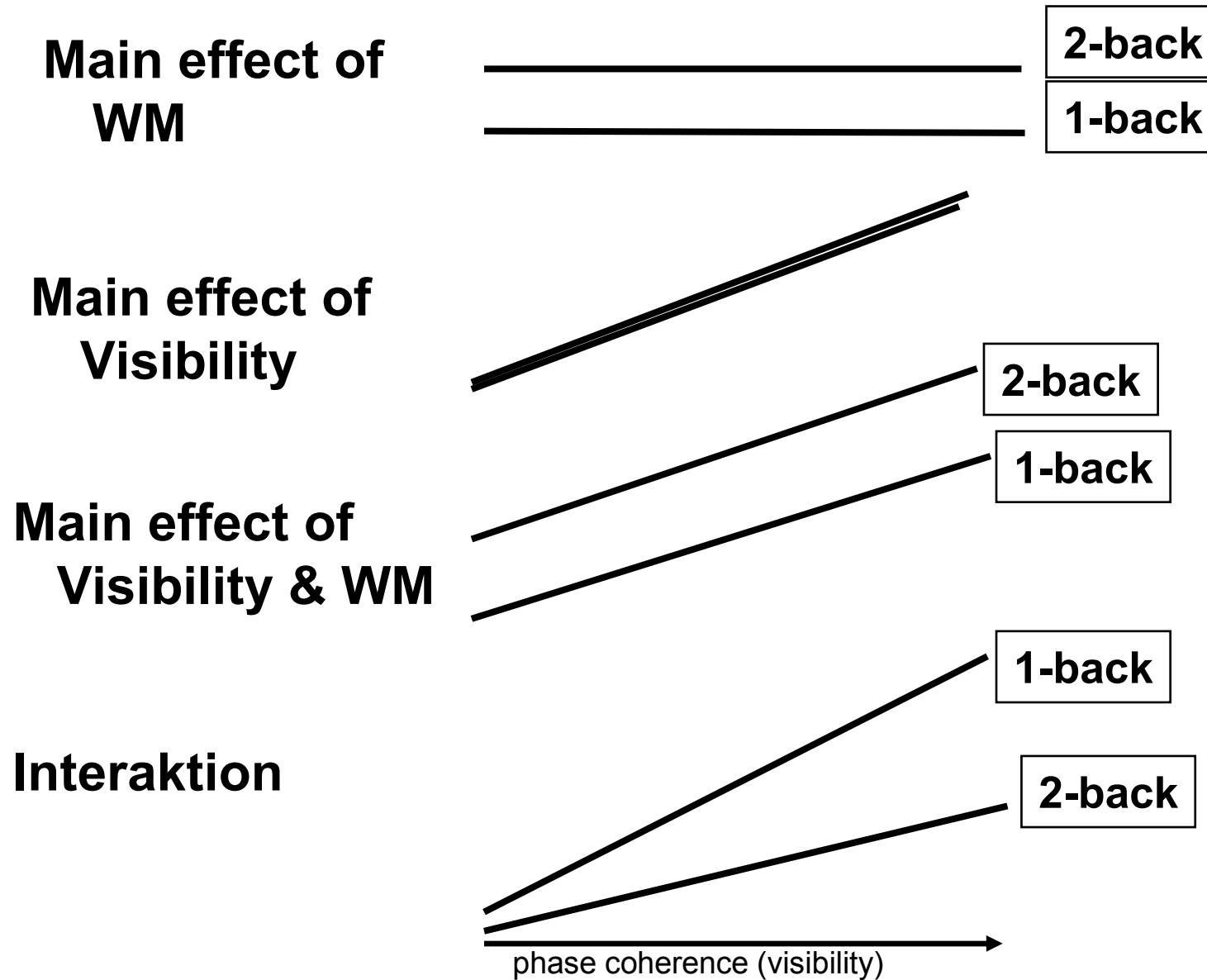
# Kategorial



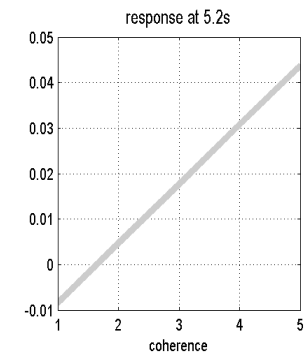
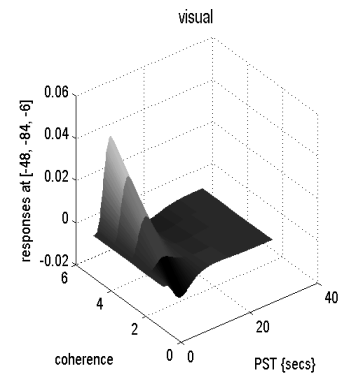
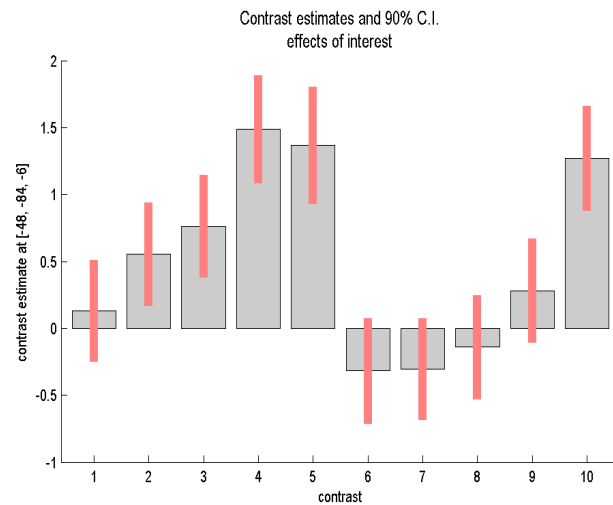
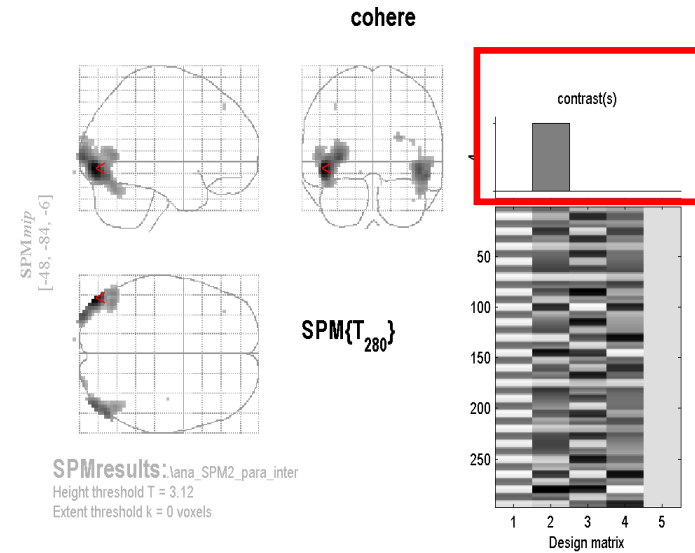
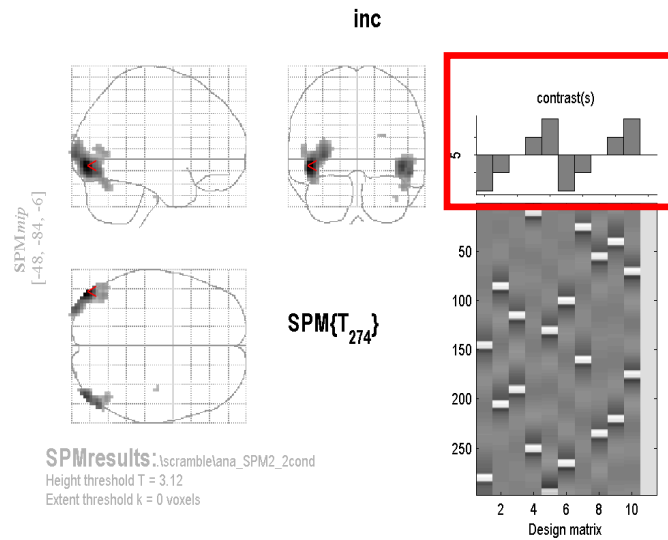
# Parametrisch



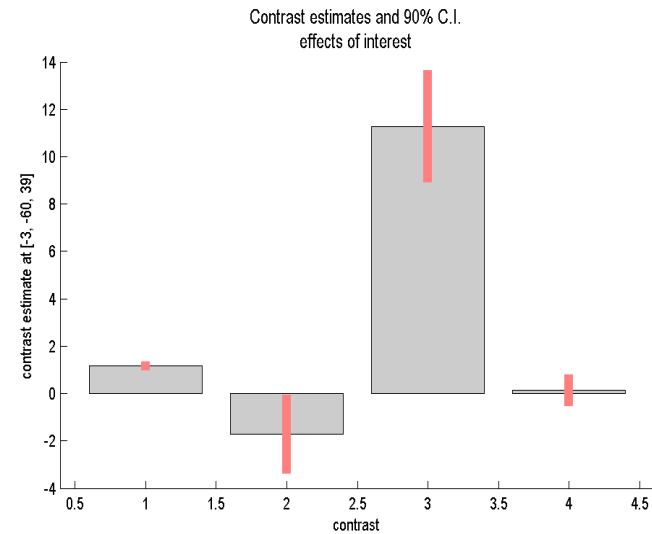
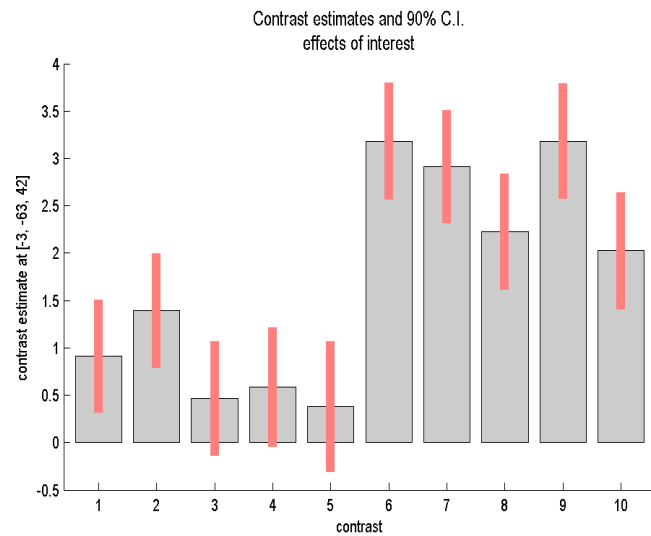
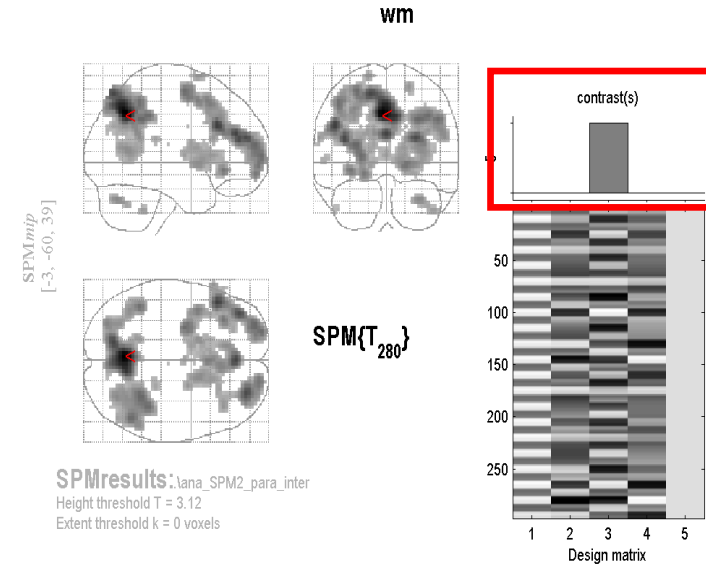
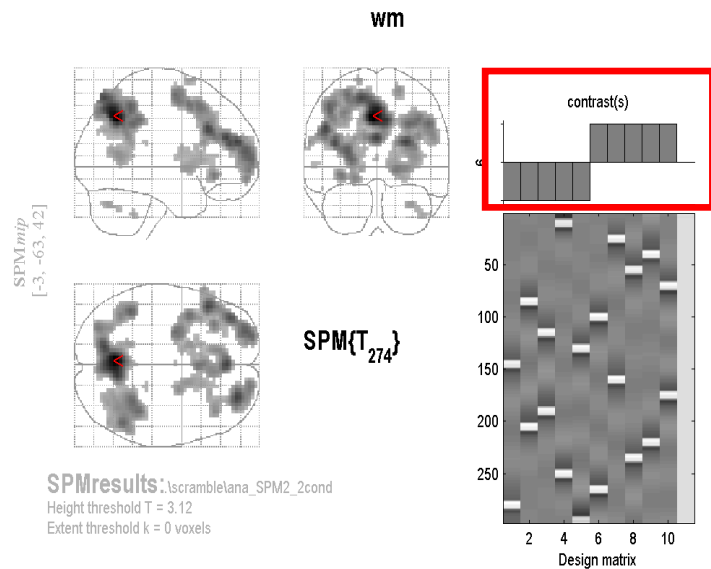
# Prototypical Responses



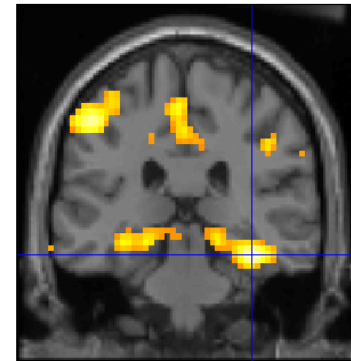
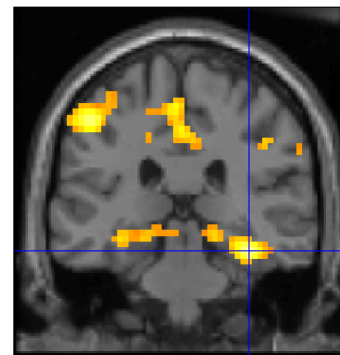
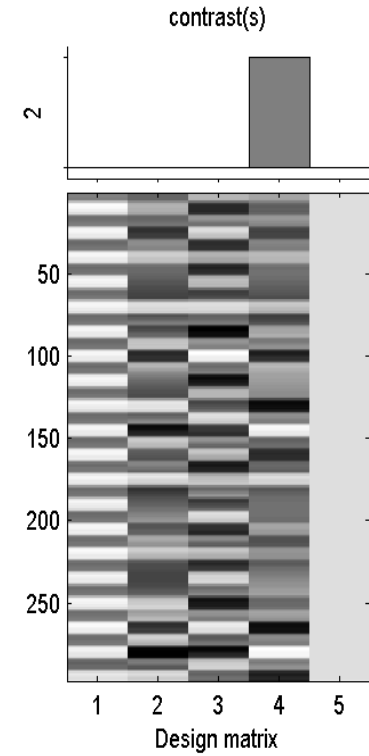
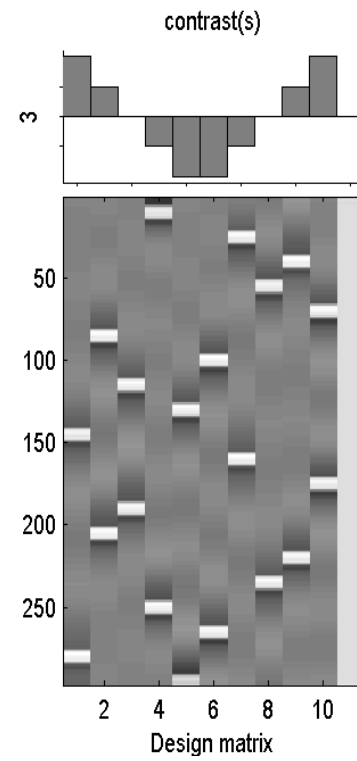
# Main effect visibility



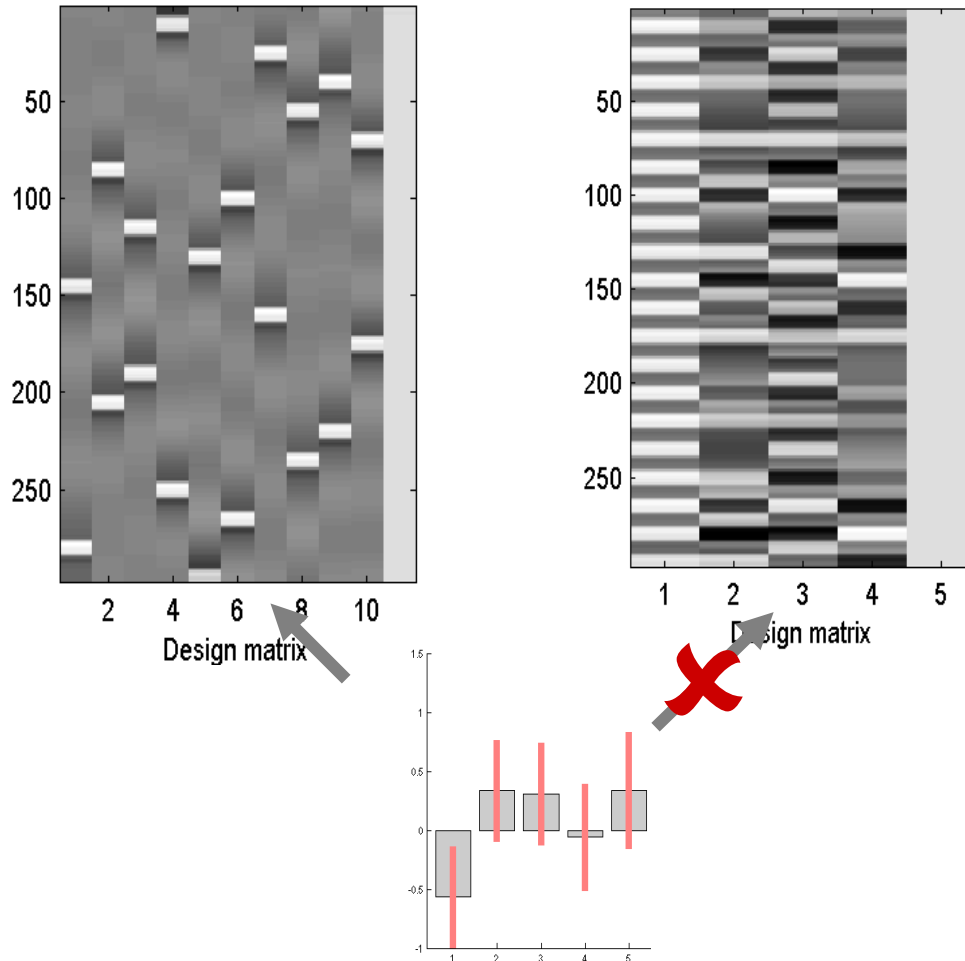
# Main effect working memory



# Interaktion



# Unterschiedliche Modelle



Die Parameter Estimates in den beiden Modellen haben eine unterschiedliche Interpretation!

Kategorischer Regressor:

„Amplitude“ der HRF

Parametrischer Regressor:

Steigung (slope) des Zusammenhanges zwischen Amplitude der HRF und dem PMod.

# Zusammenfassung

- ***Parametric Modulation***: Testen von Hypothesen über die Form der Stimulus-Antwort-Funktion  
Vorraussetzung: Trial-by-trial Maß  
→ Computationale Modelle / Ratings / Reaktionszeiten
- ***Time Modulation***: Modulator = Zeit
- Beispielstudie: Kategorial vs. Parametrisch