Emotion Word Processing:
RTs, ERPs, and Eye Movements

Sereno, Scott, Leuthold, & O'Donnell

Glasgow Language Processing

CENTRE FOR COGNITIVE NEUROIMAGING

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL
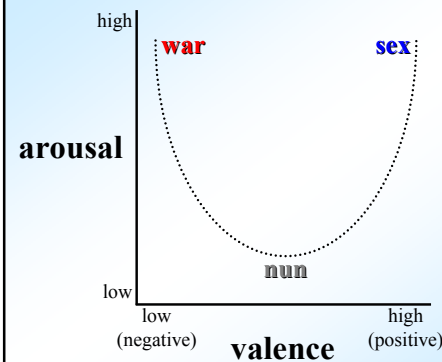
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Graham Scott

Emotion Words

- What are emotion words?
  - **Express** an emotional state (e.g., *angry*, *happy*)
  - **Elicit** an emotional state (e.g., *snake*, *puppy*)
- 2 traditional dimensions of emotion words
  - **Arousal** ≈ internal activation
  - **Valence** ≈ value or worth

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high

war   sex

arousal

nun

low

low (negative)   high (positive)

valence

RUN

Early Emotion Word Processing

- Lexical Decision (LD) / ERP experiment
  Eye Movement (EM) reading experiment

- **Word frequency**
  - High-frequency (**HF**) words are read more quickly than low-frequency (**LF**) words.
  - A *word frequency effect* (**HF<LF**) is used as a marker (index) of successful word recognition (lexical access).

Past Behavioural Experiments

Stimuli
negative vs. neutral words
positive vs. neutral words
emotional state words

In general, stimuli are not well controlled for psycholinguistic variables such as word length and frequency.

Past Behavioural Experiments

Task	**Manipulations**
lexical decision	masking
emotional decision	priming
recollection	mood induction
odd-ball paradigms	lateralised presentation
forced-choice tasks	stimulus repetition
self-referential judgments	blocked presentation

Lexical Decision

- Emotion (Pos, Neg, Neut) x Frequency (HF, LF)

- 40 words of each type (240 total words)
  - HF: Pos, Neg, Neut
  - LF: Pos, Neg, Neut

- 240 length-matched non-words
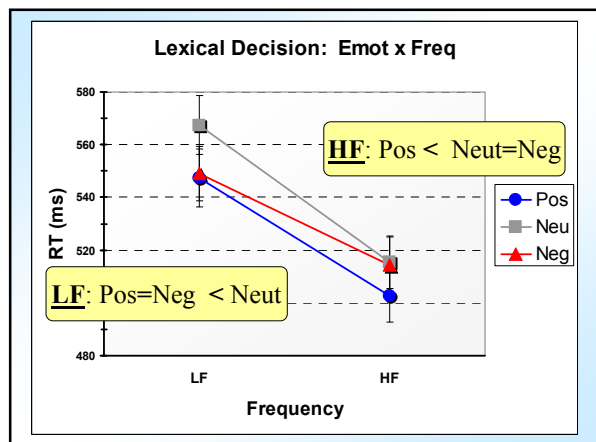 - pronounceable pseudowords (*blimble*)

Lexical Decision

- Norms
  - Arousal & Valence: ANEW (1000 words)
  - Frequency: BNC (90 million written words)

- Randomised presentation – NO repetition, lateralised presentation, priming, masking, self-referential judgments, mood induction…

- 26 participants

LD: Stimulus Specifications (N=40)

		Arousal (lo-hi, 1-9)	Valence (neg-pos, 1-9)	Freq (per mill)	Length (char)
LF	Pos	6.7	7.6	8	7
	Neut	4.5	5.2	7	7
	Neg	6.6	2.4	7	7
HF	Pos	6.6	7.8	62	6
	Neut	4.3	5.2	67	6
	Neg	6.7	2.6	50	6

rage venom detest   hawk truck invest   fame cheer elated
destroy jealousy   scissors ketchup   admired ecstasy
suffocate leprosy   pamphlet highway   valentine treasure
shark slap rude   muddy cane lump   glory sexy lust
ambulance torture   lighthouse privacy   millionaire miracle

fire anger danger   book hotel fabric   joke brave pretty
cancer divorce   manner avenue   travel birthday
accident violent   reserved village   beautiful success
abuse fear burn   bench bowl rock   happy kiss gift
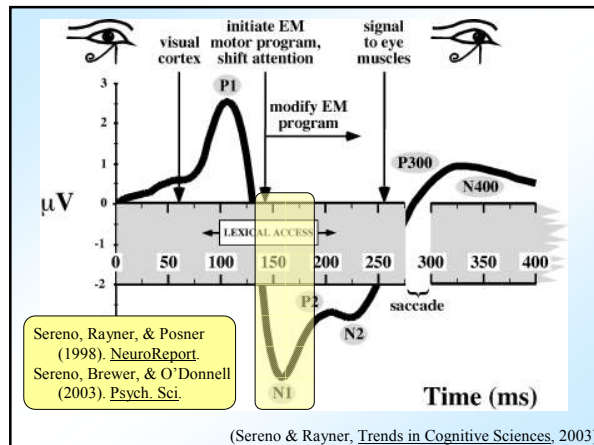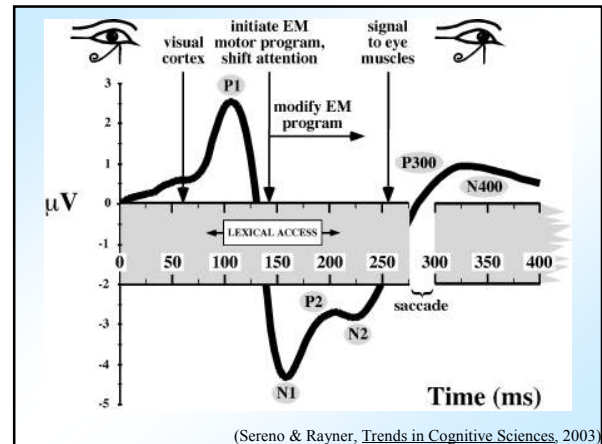suspicious panic   concentrate glass   excitement desire

Lexical Decision: Emot x Freq

RT (ms) vs Frequency (LF, HF)

Legend: Pos, Neu, Neg

HF: Pos < Neut=Neg

LF: Pos=Neg < Neut

Measurement

EMs = best on-line measure of visual word recognition in the context of normal reading

ERPs = best real-time measure of brain activity associated with the perceptual and cognitive processing of words

(Sereno & Rayner, Trends in Cognitive Sciences, 2003)

Sereno, Rayner, & Posner (1998). NeuroReport.
Sereno, Brewer, & O'Donnell (2003). Psych. Sci.

(Sereno & Rayner, Trends in Cognitive Sciences, 2003)

Past ERP Experiments

- Kanske & Kotz (2007)
  - Abstract & concrete Pos, Neg, Neut words
  - Lateralised presentation; stimulus repetition
  - Blocked: [Pos & Neut]; [Neg & Neut]
  - P2 (210-300 ms) effects, but not with go/nogo LD
- Herbert et al. (2006)
  - Pleasant, unpleasant, and neutral adjectives
  - Task: emotionally evaluate and memorise words
  - Startle response induced on 1/3 of trials!
  - P2 (180-250 ms) effects

ERP Experiment

- Same Materials/Design as in Lexical Decision

- Same 26 participants as in Lexical Decision

- Apparatus: BIOSEMI Active-Two amps
  70 electrodes
  presentation controlled by ERTS

- N1 component: 135-180 ms post-stimulus

N1 Topography
135-180 ms

N1 (135-180 ms) Voltage: Emot x Freq

HF: Pos=Neut < Neg
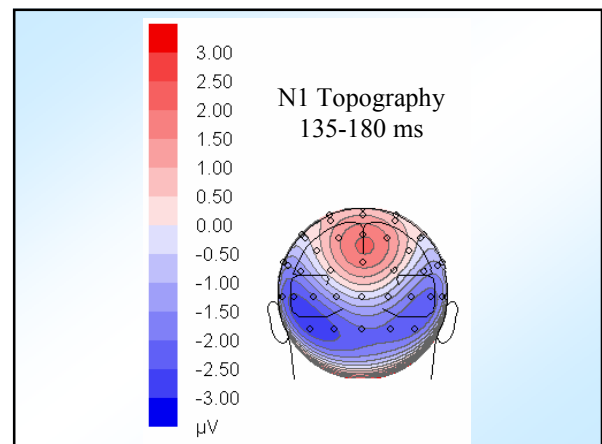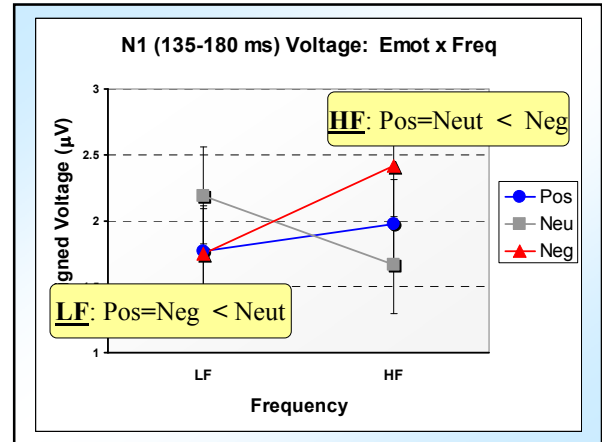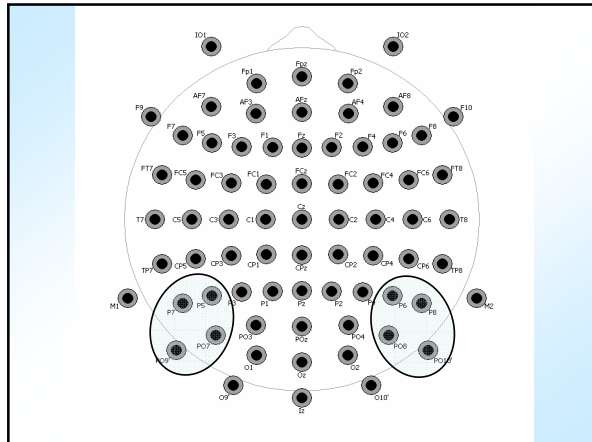
LF: Pos=Neg < Neut

Eye Movement Experiment

- No past EM emotion word experiments.

- Emot (Pos, Neg, Neut) x Freq (LF, HF)

- 15 words of each type → 90 expt sentences

- Measure fixation time on target words in neutral sentences via Dual Purkinje Eyetracker.

- 48 participants

EM: Stimulus Specifications (N=15)

		Arousal (lo-hi, 1-9)	Valence (neg-pos, 1-9)	Freq (per mill)	Length (char)
LF	Pos	6.7	7.4	5	7
	Neut	3.4	5.0	5	7
	Neg	6.4	2.6	8	7
HF	Pos	6.4	7.6	71	6
	Neut	3.9	5.3	87	6
	Neg	6.6	2.7	53	6

LF: **spider**   camel   **puppy**

Lisa read about the _____ in her animal book.
A sturdy creature, the _____ can survive in many habitats.
The documentary on the _____ was very interesting.

HF: **bomb**   news   **kiss**

Tom delivered the _____ with great care and attention.
Phoebe discussed the _____ at great length with her friends.
Michelle dreamt about the _____ every night for weeks.
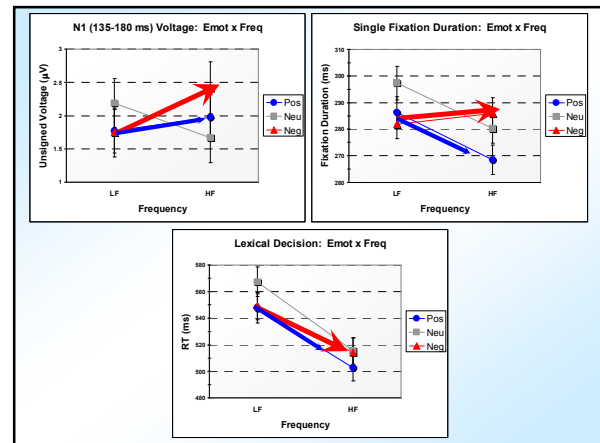

Results: Fixation Time Measures

- **Early**
  - First fixation duration (FFD)
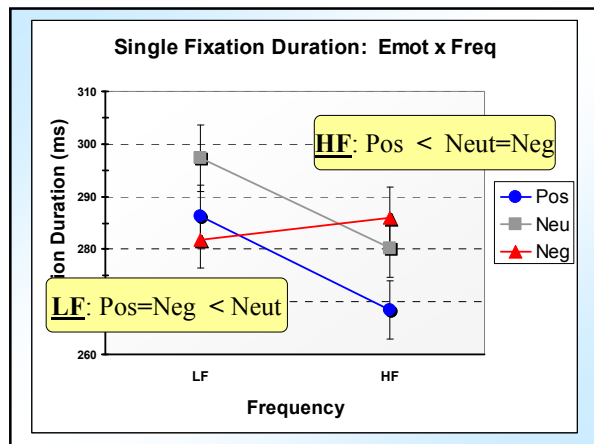 - Single fixation duration (SFD)
  - Gaze duration (GD)

reject	6%
skip	10%
1 fix	71%
2+ fix	13%

- **Later**
  - Next forward-going fixation after target ('spillover')
  - Total Fixation Time (TT)

Single Fixation Duration: Emot x Freq

Fixation Duration (ms) vs Frequency (LF, HF)

HF: Pos < Neut=Neg

LF: Pos=Neg < Neut

Legend: Pos, Neu, Neg

N1 (135-180 ms) Voltage: Emot x Freq
Unsigned Voltage (μV) vs Frequency

Single Fixation Duration: Emot x Freq
Fixation Duration (ms) vs Frequency

Lexical Decision: Emot x Freq
RT (ms) vs Frequency

Legend: Pos, Neu, Neg

N1 (135-180 ms) Voltage: Emot x Freq
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Fixation Duration (ms) vs Frequency

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Legend: Pos, Neu, Neg

Conclusion

- We examined HF and LF Pos, Neg, Neut words across 3 measures:
  LexDec, ERP, and EM reading measures.

- Reponses were modulated by 3 factors:
  Frequency, Arousal, and Valence.

- First to show early lexical effects of emotion.