Testing Spatial Language: Understanding the Trade-off between Ecological Validity and Experimental Control

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Overview

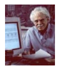
- Key debates about meaning and language – towards a framework for psychological semantics
- The trade-off between ecological validity and experimental control
- Some examples to work on
- Conclusions

Symbol-to-symbol relations versus grounding language

- **AMODAL SYMBOL SYSTEMS**
- **Chomsky**

- **Fodor (1975)**

- **Landauer & Dumais (1997)**

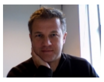


Symbol-symbol relations get us quite far - Latent Semantic Analysis (LSA)

- Theory and method for extracting and representing the contextual-usage meaning of words by statistical computations applied to a large corpus of text (Landauer & Dumais, 1997)
- **LSA performs very well when compared against humans – there is no doubting that it is impressive**
- Developments in corpus linguistics and analyses of big data (e.g. twitter/facebook)

Symbol-to-symbol relations versus **grounding language**

Larry Barsalou, Glasgow



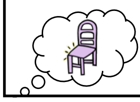
Rolf Zwaan, Rotterdam

Friedemann Pulvermuller Cambridge/Berlin

Art Glenberg, Arizona

Embodied Cognition

- Larry Barsalou proposed the Perceptual Symbol Systems (PSS) hypothesis (Barsalou, 1999; Barsalou et al., 2003; see also Wilson, 2002)
- Essentially states that
  - Mental representations are partial recordings of the neural activations that arise during perceptual and motor experiences
  - Perceptual and conceptual systems use the same systems
  - No distinction between semantic and episodic memory



e.g. Thinking of a chair involves mentally representing the perceptual symbols for chair: its shape & size (vision), material (touch), what it's like to sit on (motor), etc.

Reframing the debate?

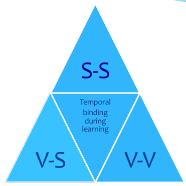
Learning language occurs in situations where infant/child and a caregiver are immersed in a spatial environment (e.g., playing with toys) working towards specific goals (e.g., fitting objects together in meaningful ways).

Language and perception co-occur during learning – but what are the consequences of this?

Language learning as multiple constraint satisfaction

- Child learns symbol-to-symbol (word-to-word) relations
- Child learns visuosymbol-to-visuosymbol relations (the visual features/events that co-occur in the world)
- Child learns how to ground words; symbol-to-visuosymbol relations

Learning a language



Claim?

Temporal binding of S-S-V-V underlie language learning. The more frequent a binding occurs, the more likely it will be instantiated at retrieval.

A situation is a regular set of bindings.

Pulvermüller (2012)

Puts together embodied and disembodied approaches to the neural basis of language.

- Merits careful consideration as a model.
- Fits most of the data (not necessarily a good thing…)

Principles of correlation learning

- Correlation learning principles operate across:
  - words and the world
  - words and aspects of actions and interactions (e.g. objects. emotions)
  - Words and other words
  - This leads to the expectation that different types of words may be associated with different networks
  - **Prestructured network whose anatomical properties co-determine the learning.**

Methods of correlation learning

- Hebbian: neurons that fire together strengthen their mutual connections and become more tightly associated; long term potentiation (Artola & Singer, 1993; Hebb, 1949)
- Neurons fire alternatingly – one is silent while another fires – mutual connections weaken; long term depression (Artola & Singer, 1993; Tsumoto, 1992)
- Human cortex has strong connections between a range of distant areas, linking neurons in frontal, temporal, parietal and occcipital lobes.

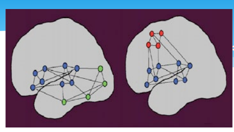


Fig. 2. Schematic illustration of cortical cell assemblies linking perisylvian word form circuits to semantic circuits in the inferiortemporalobject perception stream (diagram on the left) and in the fronto-central motor systems (right). Neuroscience principles of synaptic learning and cortical connectivity imply that these types of circuits emerge, respectively, during word-object learning and during learning of word–action correspondences. At the psychological level, the semantic circuits can be understood as schematic representations of actions and objects.

Pulvermüller (2012)

- A neural model and neurocomputational model employing the same learning principles to explain the learning of varying sets of relations:
  - word-word
  - word-action
  - word-object
  - Word-emotion, etc.

Is that it? NO

- Final ingredient… from standard memory models?
- The set of relations retrieved are the sets of relations with highest similarity to input. So:
  - Words and more words: S-S relations retrieved
  - Words and pictures: S-V relations retrieved
  - Pictures and pictures: V-V relations retrieved

Example 1: Adpositions

- Exhibit considerable cross-linguistic variation
- …but pattern of acquisition of adpositions quite consistent across languages
- Hard to learn in L2 – **why?**

Approaching the study of psychological semantics

1. **Internal versus external validity (a reminder - hopefully!)**
2. **Some (recent) examples of experiments exhibiting pitfalls**
3. **Deictic communication and adpositions- examples of methods in practice**
4. **Questions?**

1. Internal versus external validity (and the experimental method)

Research Validity

- **Internal Validity** – the validity of findings emerging from the research study; focused on the technical soundness of a study, particularly concerned with the control of extraneous influences that might effect the outcome and elimination of any confounding variables and factors
- **External Validity** – the degree to which the findings can be inferred to the population of interest or to other populations or settings; the generalizability of the results
- Both are important in a study but they are frequently at odds with one another in planning and designing a study – particularly with language
- Internal validity is the basic minimum for experimental research

Internal Validity

Particularly important in experimental studies

- Did the experimental treatment (X) produce a change in the dependent variable (Y)
  - To answer yes, one must be able to rule out the possibility of other factors producing the change
- To gain internal validity, the researcher attempts to control everything and eliminate possible extraneous influences
- Lends itself to highly controlled, laboratory settings

Compromising Internal Validity

- **History** – events occurring during the experiment that are not part of the treatment
- **Maturation** – biological or psychological processes within participants that may change due to the passing of time, e.g., aging, fatigue, hunger
- **Testing** – the effects of one test upon subsequent administrations of the same test
- **Instrumentation** – changes in testing instruments, raters, or interviewers including lack of agreement within and between observers

- **Statistical regression** – the fact that groups selected on the basis of extreme scores are not as extreme on subsequent testing
- **Selection bias** – identification of comparison groups in other than a random manner
- **Experimental mortality** – loss of participants from comparison groups due to nonrandom reasons
- **Interaction among factors** – factors can operate together to influence experimental results

External Validity

- Generalizability of results . . . to what populations, settings, or treatment variables can the results be generalized?
- Concerned with real-world applications
- What relevance do the findings have beyond the confines of the experiment?
- External validity is generally controlled by selecting subjects, treatments, experimental situations, and tests to be representative of some larger population
- Random selection is the key to controlling most threats to external validity

External Validity Types

- **Population Validity**
  - extent to which the results can be generalized from the experimental sample to a defined population
- **Ecological Validity**
  - extent to which the results of an experiment can be generalized from the set of environmental conditions in the experiment to other environmental conditions

External Validity: Threats

- **Interaction effects of testing**
  - the fact that the pretest may make the participants more aware of or sensitive to the upcoming treatment
- **Selection bias**
  - when participants are selected in a manner so they are not representative of any particular population
- **Reactive effects of experimental setting**
  - the fact that treatments in constrained laboratory settings may not be effective in less constrained, real-world settings
- **Multiple-treatment interference**
  - when participants receive more than one treatment, the effects of previous treatments may influence subsequent ones

Experimental Research Steps

- State the research problem
- Consider range of methods available: do experimental methods apply at all?
- Specify the independent variable(s)
- Specify the dependent variable(s)
- State the tentative hypotheses
- Determine measures to be used
- Identify intervening (extraneous) variables
- Formal statement of research hypotheses (write down)
- Design the experiment (write down)
- Specify procedure and put yourself in participants' shoes
- Refine, pilot as necessary, and only conduct the study when ready
- Analyze the collected data
- Prepare a research report as soon as possible afterwards

Types of Designs

- The basic structure of a research study . . . particularly relevant to experimental research
- Types of designs (Campbell & Stanley, 1963)
  - Pre-experimental
  - True experimental
  - Quasi-experimental

Pre-experimental designs

- Weak experimental designs in terms of control
- No random sampling
- Threats to internal and external validity are significant problems
- Many definite weaknesses
- Example: One-group pretest/posttest design

True experimental designs

- Best type of research design because of their ability to control threats to internal validity
- Utilizes random selection of participants and random assignment to groups
- Example: Pretest/posttest control group design

Quasi-experimental designs

- These designs lack either random selection of participants or random assignment to groups
- They lack some of the control of true experimental designs, but are generally considered to be fine
- Example: Nonequivalent group design

Methods of Control: Physical Manipulation

- Best way to control extraneous variables
- Researcher attempts to control all aspects of the research, except the experimental treatment
- Difficult to control all variables
  - Some variables cannot be physically controlled

Methods of Control: Selective Manipulation

- Intent is to increase likelihood that treatment groups are similar at the beginning of study
- Matched pairs design
  - Participants are matched according to some key variable and then randomly assigned to treatment group
  - Block design – extension of matched pairs to 3 or more groups
- Counterbalanced design
  - All participants receive all treatments, but in different orders

Methods of Control: Statistical Techniques

- Applied when physical manipulation or selective manipulation is not possible
- Differences among treatment groups are known to exist at beginning of study
  - Groups may differ on initial ability
- Analysis of covariance (ANCOVA)
  - Adjusts scores at the end of the study based upon initial differences

Sources of Error

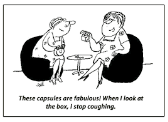
- Many possible sources of error can cause the results of a research study to be incorrectly interpreted. The following sources of error are more specific threats to the validity of a study than those described previously
- Selected examples:
  - Hawthorne Effect
  - Placebo Effect
  - John Henry Effect
  - Rating Effect
  - Experimenter Bias Effect

Hawthorne Effect

- A specific type of reactive effect in which merely being a research participant in an investigation may affect behavior
- Suggests that, as much as possible, participants should be unaware they are in an experiment and unaware of the hypothesized outcome

Placebo Effect

- Participants may believe that the experimental treatment is supposed to change them, so they respond to the treatment with a change in performance



John Henry Effect

- A threat to internal validity wherein research participants in the control group try harder just because they are in the control group.

Rating Effect

- Variety of errors associated with ratings of a participant or group
  - Halo effect
  - Devil effect
  - Overrater error
  - Underrater error
  - Central tendency error

Experimenter Bias Effect

- The intentional or unintentional influence that an experimenter (researcher) may exert on a study

The Clever Hans Effect

The psychologist Oskar Pfungst investigated Hans and discovered that Hans could only solve problems when
(a) The questioner knew what the answer was and
(b) The horse could see the questioner.

High external validity

High internal

Low external validity

Low internal

2. Some recent examples of experiments exhibiting pitfalls

Embodied cognition: a cautionary tale?

Larry Barsalou, Glasgow

Rolf Zwaan, Rotterdam

Freidemann Pulvermuller Cambridge/Berlin

Art Glenberg, Arizona

Embodied Cognition

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- Essentially states that
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e.g. Thinking of a chair involves mentally representing the perceptual symbols for chair: its shape & size (vision), material (touch), what it's like to sit on (motor), etc.

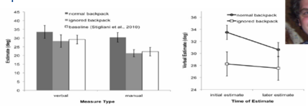
Top down effects on Perception?

- **Proffitt**, Witt, Stefanucci, Schnall, Balcetis and colleagues – perception affected by cognition and emotion.
- E.g. Bhalla and Proffitt (1999) – slope judgement

People judge slopes as steeper when wearing a heavy backpack.

Durgin et al. (2009, 2011, 2012)

* Slope studies a result of demand characteristics



People judge slopes as steeper when wearing a heavy backpack because they know that the backpack is supposed to affect their judgements

Firestone (2013; Firestone & Scholl, 2015)

* Arguments against top down effects in perception
* Against "paternalistic" approaches to perception
* 100s of studies fall prey to only a handful of pitfalls
  * Over confirmatory hypotheses
  * Perception versus judgement?
  * Demand and response bias
  * Low level confounds
  * Attention versus low level vision?
  * Memory and recognition versus encoding

* Let me add: Effect sizes are often very small (e.g. microaffordance effects). If these high level effects are so im

The evidence base for top down effects on perception is currently weak – at least according to Firestone & Scholl.

Embodied Language processing?

* Evidence for embodiment of motor information
  * **directional motion response** (Glenberg & Kaschak, 2002)
* Get participants to rest finger on the middle of a near-far button box and present them with a short sentence:

"Open the drawer."
"Close the drawer."

* Ask ppts to respond y/n if the sentence makes sense

People are faster to respond "yes" for the "close the drawer" sentence (*away* motion matches *away* sentence direction) than for the "open the drawer" sentence (*away* motion mismatches *towards* sentence direction)

Failures to replicate the ACE: Papesh (2015)

* 8 experiments and meta-analyses fail to support the ACE.
* Scales JZS Bayes factor values computed for past studies Bayesian analyses of literature shows effects in the main are weak or non-existent.

For an embodied hypothesis of language processing based on the strength of the current data the should be "Under certain circumstances, and in certain linguistic tasks, comprehending an effector-specific verb while simultaneously using that effector will produce interference, but will sometimes produce facilitation. It depends."

WEIRD participants?

* Psychological studies do not often adequately sample our species – findings may not be representative.
* **W**estern, **E**ducated, **I**ndustrialized, **R**ich and **D**emocratic

Henrich, Heine & Norenzayan (2010). The weirdest people in the world? *Behavioral and Brain Sciences, 33*, 61-135.

Language universals?

* The world's 6,000-8,000 languages vary radically in sound, meaning, and syntactic organization.
* Linguistic universals are few and unprofound.

Evans &
diversi
Science

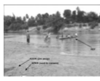
3. Deictic communication and spatial adpositions - examples of methods in practice

Observation and coding

Enfield, N. J. (2003). Demonstratives in space and interaction: data from Lao speakers and implications for semantic analysis. *Language, 79(1)*, 82-117

Method: Video recordings of spontaneous spee (Southwestern Tai, Laos), with use of informan

Analyses: Descriptive analyses of use. No stats.



boat.

some in?

Conclusions

Linguistic analyses (descriptive) regarding the conditions under which the two demonstratives are used.

Findings: Lao nii4 and nan4 do not encode a simple proximal versus distal spatial distinction.

Neither specify how far away an object is, and only nan4 specifies 'where' it is. Informativeness contrast with rich pragmatic inferencing.

Enfield calls for the use of recordings of spontaneous interactions.

Experimental tasks 1

Bangeter, A. (2004). Using pointing and describing to achieve joint focus of atter In dialogue. *Psychological Science*, 15(6), 415-419.

Method: Pairs of participants point and describe arrays, with the arrays at different distances. One participant (Director) had named photos. The other participants (matcher) had to match names to photos, writing then down.

Design: 2(visibility: participants could see each other or not) x 4 (distance) mixed design Distances within participants in blocks – randomly presented (??)

Analyses: Frequency of pointing with deictic expressions as a function of distance and visibility.

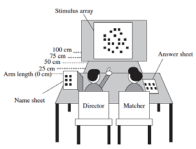


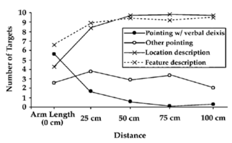
Fig. 1. Experimental setup.

Hypotheses

1) The relative use of pointing and language varies according to the situation. As pointing becomes ambiguous, speakers will rely on it less and compensate with language.
2) The second was that pointing is not redundant with speech. It reduces verbal effort to identify a target.
3) Pointing focuses attention by directing gaze to the target region.

Findings

- Visible pairs pointed 52% of the time, with one third of these accompanied by deixis (e.g. pointing and saying "That's John")
- Visible pairs used fewer words as the target got closer; hidden pairs did not
- Pointing more frequent with deixis for closer locations
- The two types of pointing affected verbal effort differently. The number of words used per array correlated negatively with the number of points with deixis ($r = -.62$, $n=50$, $p < .001$), but was unrelated to the number of other points.



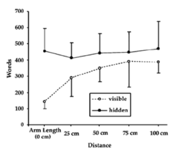


Fig. 3. Mean total number of words used per array as a function of visibility and distance.

My Work - Demonstrative team

Debra Griffiths, University of East Anglia, UK

Colin Hamilton, Northumbria University Newcastle, UK

Pedro Guijarro-Fuentes, Universidad de les Illes Balears, Mallorca

Berenice Valdés, Universidad Complutense de Madrid, Spain

Alejandro Castillo, Universidad de Murcia, Spain

Harmen Gudde, University of East Anglia (UK)

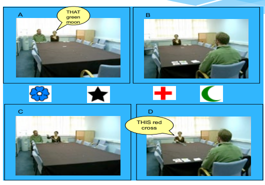
Paul Engelhardt, University of East Anglia (UK)

E·S·R·C Economic & Social Research Council

Arts & Humanities Research Council

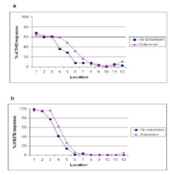
UEA University of East Anglia

'Memory Game' Experiment

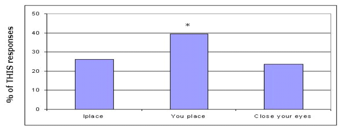


Coventry, K. R., Valdés, B., Castillo, A., & Guijarro-Fuentes, P. (2008). Language within your reach. Near-far perceptual space and spatial demonstratives. *Cognition, 108,* 889-895.

- Manipulations:
  - Where object is placed: **distance** from speaker
  - Who places the object: object in peripersonal space immediately prior to description?
  - Pointing with arm or with a tool (extension of peripersonal space mirroring Berti & Frasinetti, 2000?)



Previously contacting an object matters for English



- Is there a basic set of vision and action distinctions underlying demonstrative use across languages?

  Does spatial demonstrative choice mirror nonlinguistic representation of space?

- Are lexical distinctions really indicative of variables that affect language use?

Experiment 1: Ownership and Demonstrative Choice

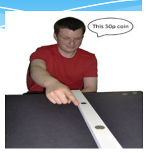
- Whether an object is owned or not is lexicalised in some demonstrative systems (e.g. **Supyire**; Diessel, 1999)
- What about English?

2(ownership) x 2(who places) x 3(location) design (N=25)

Ownership: participant's money or experimenter's money

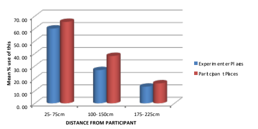
Manipulations

- Participant places his coin
- Participant places experimenter's coin
- Experimenter places her coin
- Experimenter places participant's coin



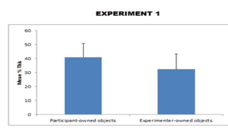
Who places effect? Location effect?

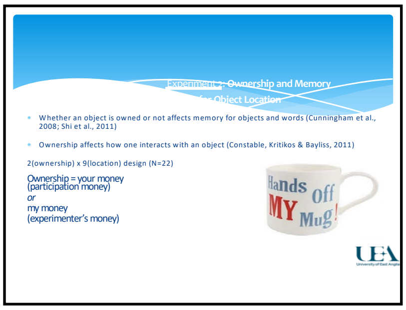
YES: main effect of who places, $F(1, 24) = 5.79$, $p = .02$, partial $\eta^2 = .194$;
YES: main effect of location, $F(2, 48) = 30.40$, $p < .0001$, partial $\eta^2 = .559$

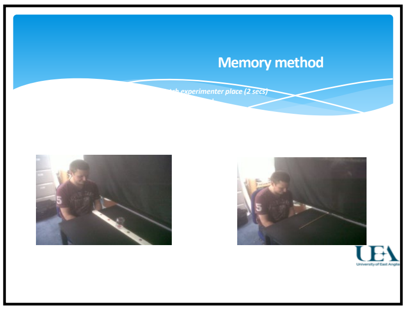


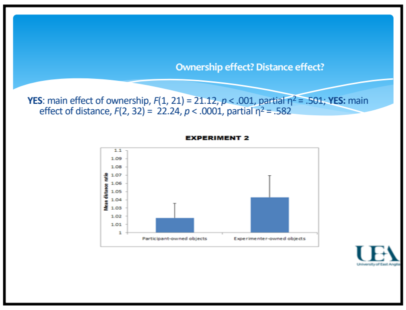
Ownership effect?

YES: main effect of ownership, $F(1, 24) = 7.44$, $p = .01$, partial $\eta^2 = .237$

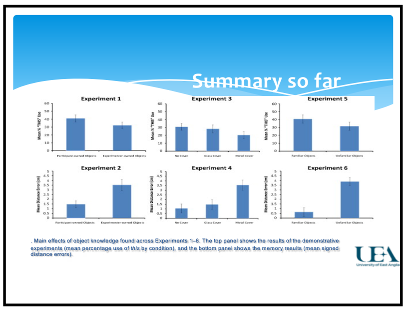


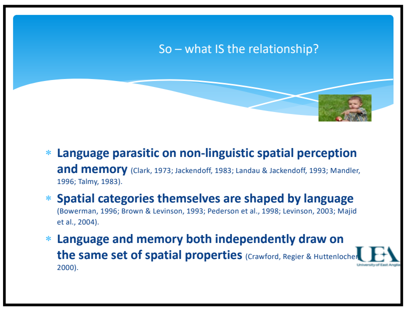

Experiment 2: Ownership and Memory
for Object Location
Whether an object is owned or not affects memory for objects and words (Cunningham et al., 2008; Shi et al., 2011)
Ownership affects how one interacts with an object (Constable, Kritikos & Bayliss, 2011)
2(ownership) x 9(location) design (N=22)
Ownership = your money
(participation money)
or
my money
(experimenter's money)
Hands off MY Mug!
UEA

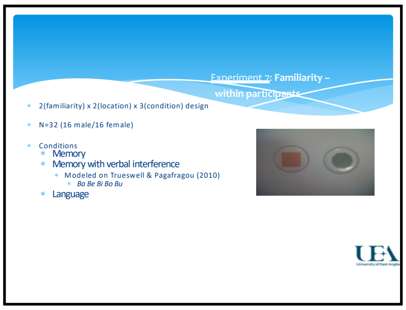

Memory method
experimenter place (2 secs)
UEA

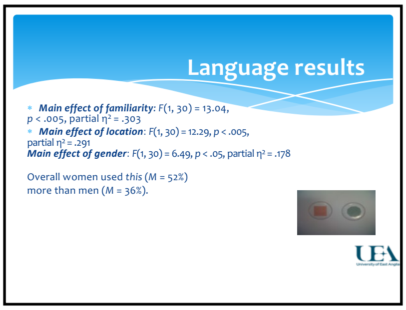

Ownership effect? Distance effect?
YES: main effect of ownership, F(1, 21) = 21.12, p < .001, partial η² = .501; YES: main effect of distance, F(2, 32) = 22.24, p < .0001, partial η² = .582
EXPERIMENT 2
Mean distance ratio
Participant-owned objects
Experimenter-owned objects
UEA

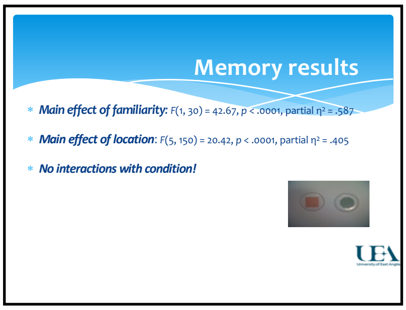

Other Expts:
VISIBILITY: Whether an object is visible or not is lexicalised in some demonstrative systems (e.g. Tiriyó, Meira, 2003; Sinhalese, Diessel, 2005)
FAMILIARITY
UEA

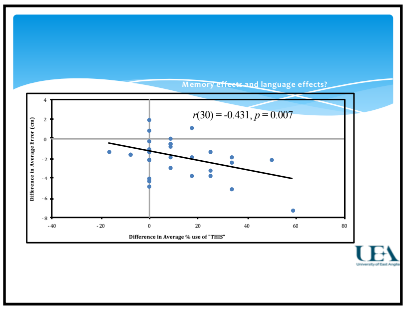

Summary so far
Experiment 1
Experiment 3
Experiment 5
Experiment 2
Experiment 4
Experiment 6
. Main effects of object knowledge found across Experiments 1–6. The top panel shows the results of the demonstrative experiments (mean percentage use of this by condition), and the bottom panel shows the memory results (mean signed distance errors).
UEA

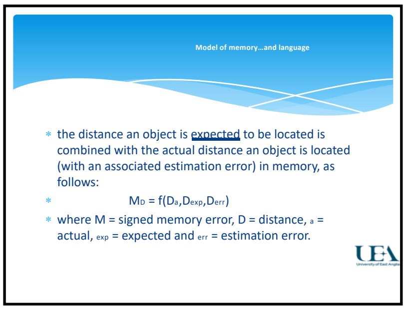

So – what IS the relationship?
Language parasitic on non-linguistic spatial perception and memory (Clark, 1973; Jackendoff, 1983; Landau & Jackendoff, 1993; Mandler, 1996; Talmy, 1983).
Spatial categories themselves are shaped by language (Bowerman, 1996; Brown & Levinson, 1993; Pederson et al., 1998; Levinson, 2003; Majid et al., 2004).
Language and memory both independently draw on the same set of spatial properties (Crawford, Regier & Huttenlocher 2000).
UEA

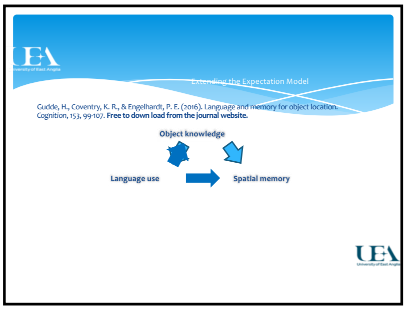

Experiment 7: Familiarity –
within participants
2(familiarity) x 2(location) x 3(condition) design
N=32 (16 male/16 female)
Conditions
Memory
Memory with verbal interference
Modeled on Trueswell & Pagafragou (2010)
Ba Be Bi Bo Bu
Language
UEA

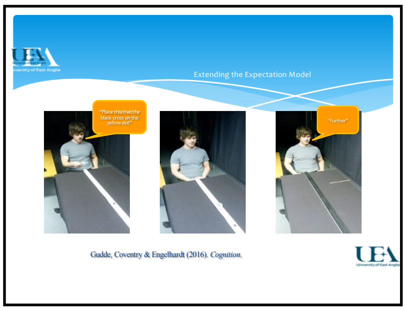

Language results
Main effect of familiarity: F(1, 30) = 13.04, p < .005, partial η² = .303
Main effect of location: F(1, 30) = 12.29, p < .005, partial η² = .291
Main effect of gender: F(1, 30) = 6.49, p < .05, partial η² = .178
Overall women used this (M = 52%) more than men (M = 36%).
UEA

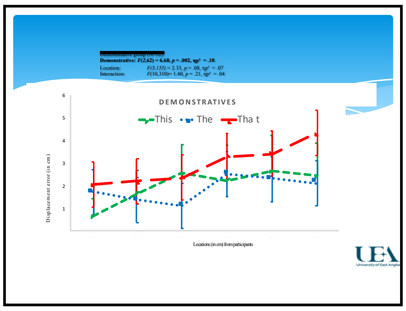

Memory results
Main effect of familiarity: F(1, 30) = 42.67, p < .0001, partial η² = .587
Main effect of location: F(5, 150) = 20.42, p < .0001, partial η² = .405
No interactions with condition!
UEA

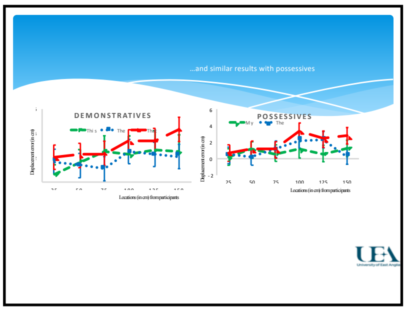

Memory effects and language effects?
r(30) = -0.431, p = 0.007
Difference in Average Error (cm)
Difference in Average % use of "THIS"

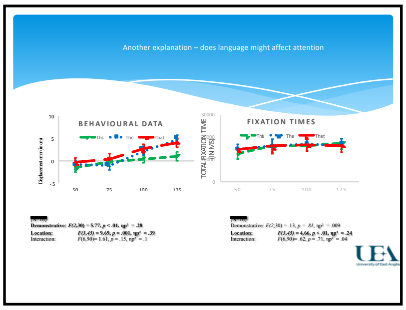

Model of memory…and language
the distance an object is expected to be located is combined with the actual distance an object is located (with an associated estimation error) in memory, as follows:
$M_D = f(D_a, D_{exp}, D_{err})$
where M = signed memory error, D = distance, $_a$ = actual, $_{exp}$ = expected and $_{err}$ = estimation error.

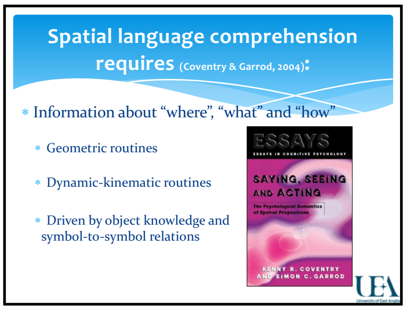

Extending the Expectation Model
Gudde, H., Coventry, K. R., & Engelhardt, P. E. (2016). Language and memory for object location. Cognition, 153, 99-107. Free to down load from the journal website.
Object knowledge
Language use
Spatial memory

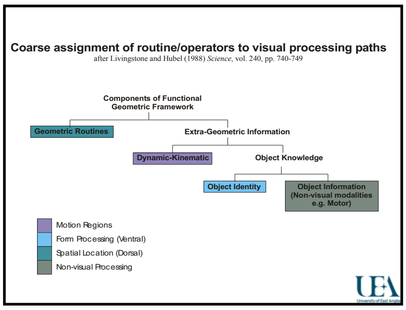

Extending the Expectation Model
Gudde, Coventry & Engelhardt (2016). Cognition.

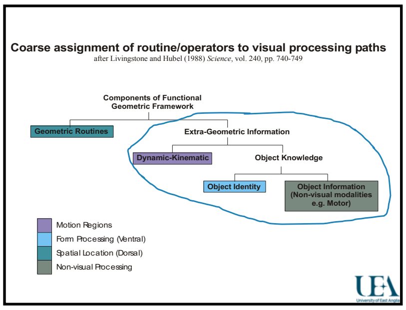

[redacted]
Demonstrative: F(2,62) = 6.68, p = .002, ηp² = .18
Location: F(5,155) = 2.33, p = .08, ηp² = .07
Interaction: F(10,310)= 1.40, p = .21, ηp² = .04
DEMONSTRATIVES
This
The
Tha t


…and similar results with possessives
DEMONSTRATIVES
POSSESSIVES


Another explanation – does language might affect attention
BEHAVIOURAL DATA
FIXATION TIMES
This
The
That
TOTAL FIXATION TIME (IN MS)
[redacted]
Demonstrative: F(2,30) = 5.77, p < .01, ηp² = .28
Location: F(3,45) = 9.69, p = .001, ηp² = .39
Interaction: F(6,90)= 1.61, p = .15, ηp² = .1
[redacted]
Demonstrative: F(2,30) = .13, p = .81, ηp² = .009
Location: F(3,45) = 4.66, p < .01, ηp² = .24
Interaction: F(6,90)= .62, p = .71, ηp² = .04


Spatial language comprehension requires (Coventry & Garrod, 2004):
Information about "where", "what" and "how"
Geometric routines
Dynamic-kinematic routines
Driven by object knowledge and symbol-to-symbol relations
ESSAYS IN COGNITIVE PSYCHOLOGY
SAYING, SEEING AND ACTING
The Psychological Semantics of Spatial Prepositions
KENNY R. COVENTRY AND SIMON C. GARROD


Coarse assignment of routine/operators to visual processing paths
after Livingstone and Hubel (1988) Science, vol. 240, pp. 740-749
Components of Functional Geometric Framework
Geometric Routines
Extra-Geometric Information
Dynamic-Kinematic
Object Knowledge
Object Identity
Object Information (Non-visual modalities e.g. Motor)
Motion Regions
Form Processing (Ventral)
Spatial Location (Dorsal)
Non-visual Processing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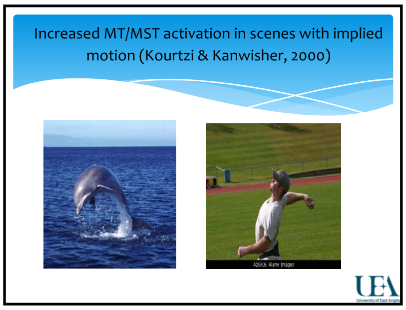
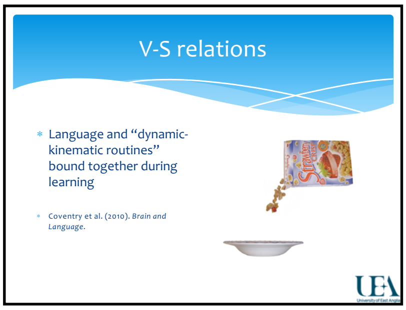
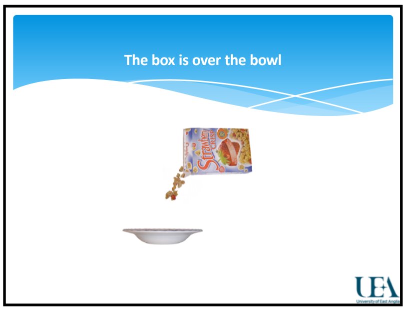
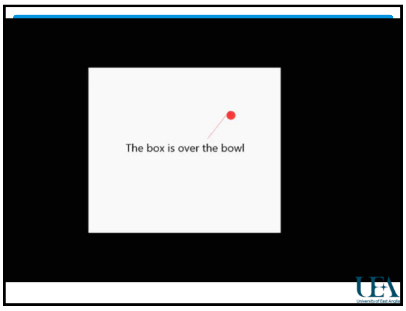
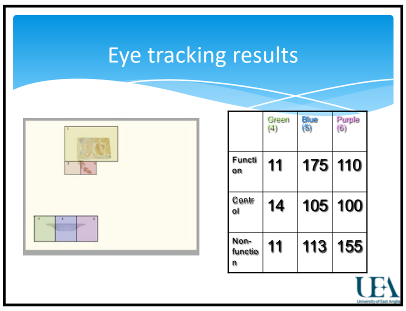
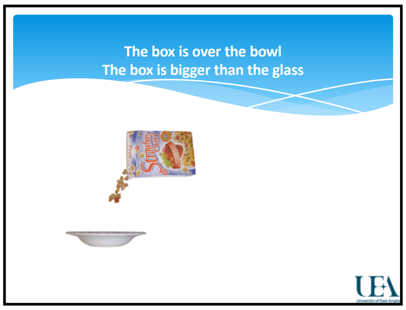

Increased MT/MST activation in scenes with implied motion (Kourtzi & Kanwisher, 2000)

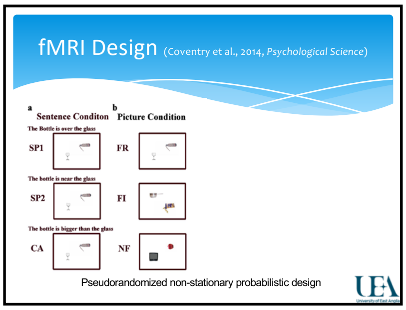

V-S relations
Language and "dynamic-kinematic routines" bound together during learning
Coventry et al. (2010). Brain and Language.

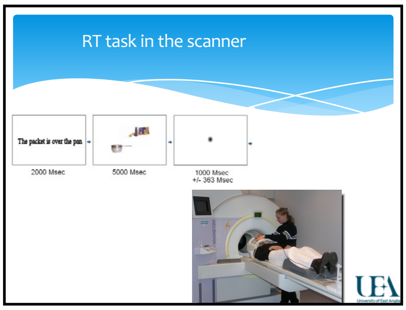

The box is over the bowl

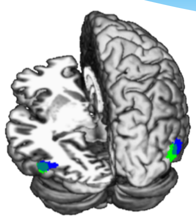

The box is over the bowl

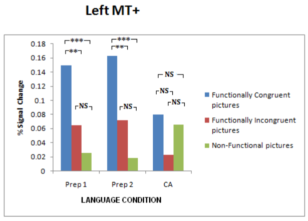

Eye tracking results
Green (4)
Blue (5)
Purple (6)
Function 11 175 110
Control 14 105 100
Non-function 11 113 155


The box is over the bowl
The box is bigger than the glass


fMRI Design (Coventry et al., 2014, Psychological Science)
a Sentence Conditon
b Picture Condition
The Bottle is over the glass
SP1
FR
The bottle is near the glass
SP2
FI
The bottle is bigger than the glass
CA
NF
Pseudorandomized non-stationary probabilistic design


RT task in the scanner
The packet is over the pan
2000 Msec
5000 Msec
1000 Msec +/- 363 Msec





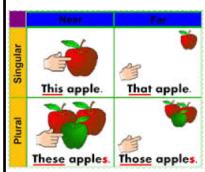
S-S relations (Coventry, Carmichael & Garrod, 1994; Coventry & Prat-Sala, 2001; Feist & Gentner, 1998)

- PLATE (*on*) versus DISH (*in*)

Why are Adpositions so difficult to learn in L2?

- Because the cross-linguistic variation is associated with S-S relations that have to be learned. (And some of the relations are low frequency.)
- V-V and V-S relations do not help!

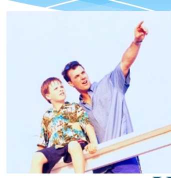
Example 2: Demonstratives



- Exhibit considerable cross-linguistic variation
- …but pattern of acquisition of adpositions quite consistent across languages
- Easy to learn in L2?

Demonstrative systems vary across languages

- Diesel (2005)
  - Sampled 234 languages from diverse families and geographical regions.
  - 55% of languages sampled lexicalised a binary proximal/distal contrast
  - 28% of language more finally differentiated distance lexically
  - More complex languages: *ownership/visibility/reference frame*

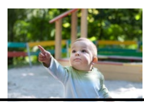


Kemmerer (1999)

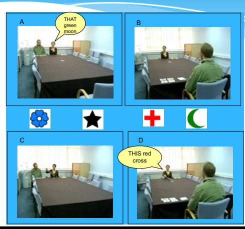
- "Demonstratives constitute an interesting case of divergence between linguistic and perceptual representations of space." (1999, p. 56; see also Enfi)
- No correspondence between near and far perceptual space and demonstrative use?

"What", "where" and "how" affect demonstrative choice

- Coventry et al. (2008). *Cognition.*
- Coventry, Griffiths & Hamilton (2015). *Cognitive Psychology.*
- Gudde, Coventry & Engelhardt (2016). *Cognition.*



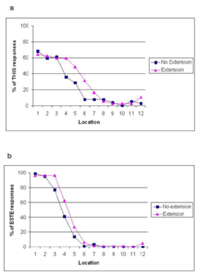
Demonstrative 'Memory Game' Experiment



Coventry, Valdés, Castillo, & Guijarro-Fuentes (2008). *Cognition.*

- Manipulations:
  - Where object is placed: **distance** from speaker
  - Who places the object: object in peripersonal space immediately prior to description?
  - Pointing with arm or with a tool (extension of peripersonal space mirroring Berti & Frasinetti, 2000?)

Near/far



Ownership and Demonstrative Choice

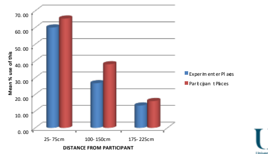
- Whether an object is owned or not or not (Supyire; Diessel, 1999)
- English?
- 2(ownership) x 2(who places) x 3(location) design
- N=25
- Ownership = your money (participation money) or my money (experimenter's money)

Manipulations

- Participant places his coin
- Participant places experimenter's coin
- Experimenter places her coin
- Experimenter places participant's coin

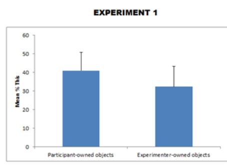
Who places effect? Location effect?

YES: main effect of who places, $F(1, 24) = 5.79$, $p = .02$, partial $\eta^2 = .194$; **YES:** main effect of location, $F(2, 48) = 30.40$, $p < .0001$, partial $\eta^2 = .559$



Ownership effect?

YES: main effect of ownership, $F(1, 24) = 7.44$, $p = .01$, partial $\eta^2 = .237$

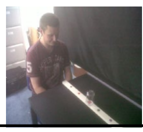


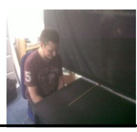
Ownership and Memory for Object Location

- Whether an object is owned or not or not affects memory for objects and words (Cunningham et al., 2008; Shi et al., 2011)
- Ownership affects how one interacts with an object (Constable, Kritikos & Bayliss, 2011)
- 2(ownership) x 9(location) design
- N=22
- Ownership = your money (participation money) or my money (experimenter's money)

Memory method

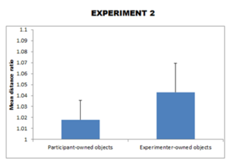
Watch experimenter place (2 secs)
↓
Watch (10 secs)
↓
Eye closed (20 secs)
↓





Ownership effect? Distance effect?

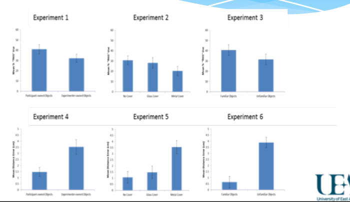
YES: main effect of ownership, $F(1, 21) = 21.12$, $p < .001$, partial $\eta^2 = .501$; **YES:** main effect of distance, $F(2, 32) = 22.24$, $p < .0001$, partial $\eta^2 = .582$



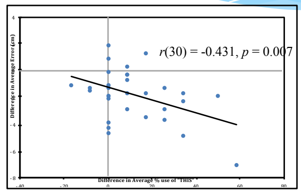
Other parameters?

* Visibility
* Familiarity
* Position of a conspecific
* Handedness and pointing with preferred/dispreferred hand
* Working across 40+ languages currently in DCOMM, including:
  * Latvian, common Estonian, Võro, Turkish, Japanese, Maltese, Norwegian, Danish, Italian, Spanish, Catalan, Sinhalese, etc.

Language and memory results converge



Memory effects and language effects?



Model of memory…and language

* the distance an object is expected to be located is combined with the actual distance an object is located (with an associated estimation error) in memory, as follows:
* $M_D = f(D_a, D_{exp}, D_{err})$
* where M = signed memory error, D = distance, $_a$ = actual, $_{exp}$ = expected and $_{err}$ = estimation error.

Where do expectations come from?

* S-S: frequency (words co-occuring with other words – perhaps not so informative with demonstratives)
* V-V: frequency. Objects becomes associated with different spaces. Demonstratives – a word class where V-V relations are at a premium.
* S-V: words becomes associated with different objects and spaces.

How does one study expectations?

* Systematic manipulation of frequency of co-occurrence, (akin to transitional probabilities)
  * Experimentally
  * Recording of real co-occurrences (e.g. Deb Roy, Linda Smith)
  * Modeling, with associated predictions for empirical testing

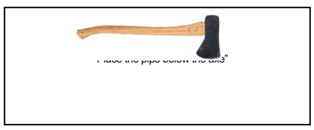
How does one get at meaning change?

* How can one measure situation-specific meaning change over time?
  * Literally – we can MEASURE it!
  * Use of large between participant designs

Testing in shopping malls with high footfalls

Object placement task

* Participant given a sentence.
* Reference object displayed
* Located object given to participants to place…



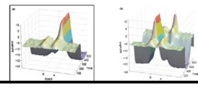
Questions

- How stable is situation-specific meaning?
- Can it change over short time scales?
- If so, how does it change?
- How can word meaning *appear* stable yet change over short timescales?

Modelling meaning: Is word meaning is like the A not B error?

A not B error in development

- Smith and Thelen (2003)
  - Traditionally, A not B error demonstrates a lack of object permanence in 10-month old infants
    - After a number of trials at position A, infants fail on a trial at position B.
    - Error does not appear at 12-months
  - When modelled as a dynamic system
    - Previous trials provide an attractor at A
    - Cue to B is strong, but fades quickly due to attractor A



The importance of action in representation: changing position changes search behaviour

Some predictions

- Stored attractor states = position plus function (*plus action?*)
- Past use affects current use
- Similar A not B errors effects for spatial language?

Experiment 1

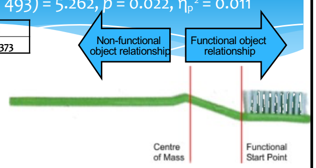
- 2 or 4 prime trials
- Object Relationship in prime trials (Functional or Non-Functional)
- Object relationship in probe trial (Functional or Non-Functional))

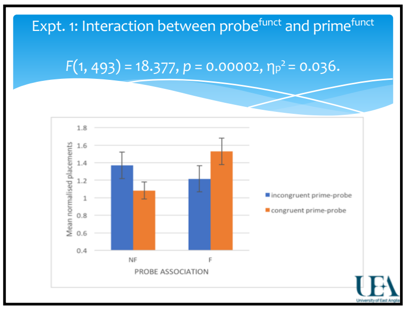
	Prime 1	Prime 2	Prime 3	Prime 4	Probe
1)	F	F	F	F	F
2)	F	F	F	F	NF
3)	NF	NF	NF	NF	NF
4)	NF	NF	NF	NF	F
5)	F	F			F
6)	F	F			NF
7)	NF	NF			NF
8)	NF	NF			F

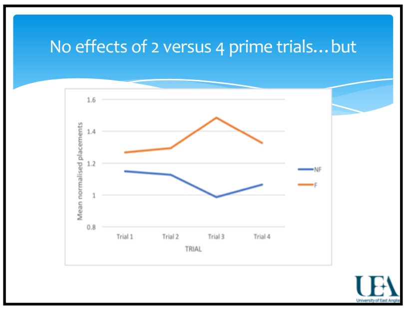
Main effect of object association of probe

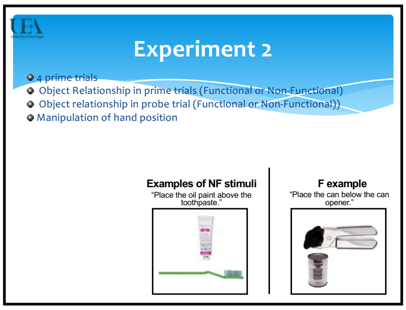
$F(1, 493) = 5.262$, $p = 0.022$, $\eta_p{}^2 = 0.011$

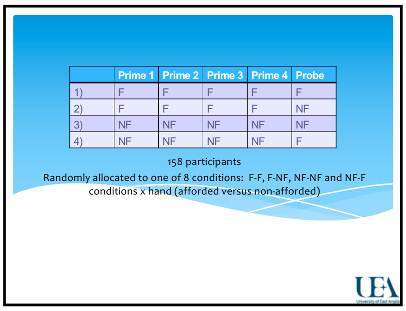
NF	F
1.199	1.373

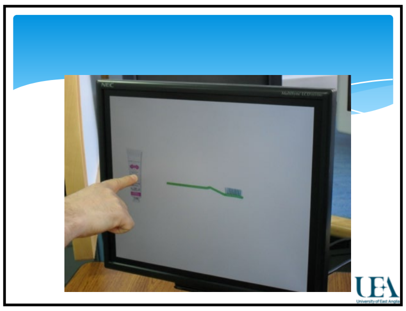


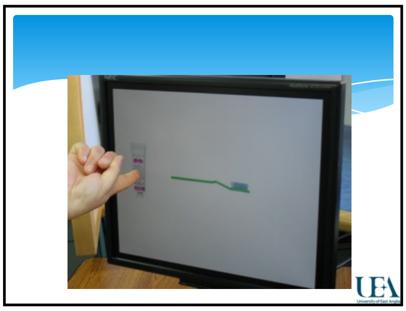

Expt. 1: Interaction between probe^funct and prime^funct
F(1, 493) = 18.377, p = 0.00002, ηp² = 0.036.
Mean normalised placements
incongruent prime-probe
congruent prime-probe
NF
F
PROBE ASSOCIATION

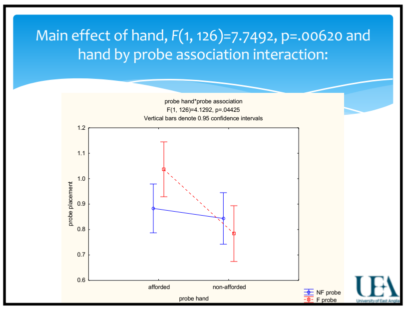

No effects of 2 versus 4 prime trials…but
Mean normalised placements
Trial 1
Trial 2
Trial 3
Trial 4
TRIAL
NF
F

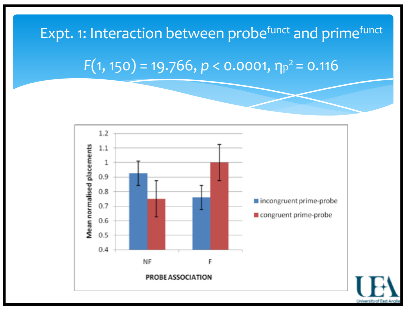

Experiment 2
4 prime trials
Object Relationship in prime trials (Functional or Non-Functional)
Object relationship in probe trial (Functional or Non-Functional))
Manipulation of hand position
Examples of NF stimuli
"Place the oil paint above the toothpaste."
F example
"Place the can below the can opener."

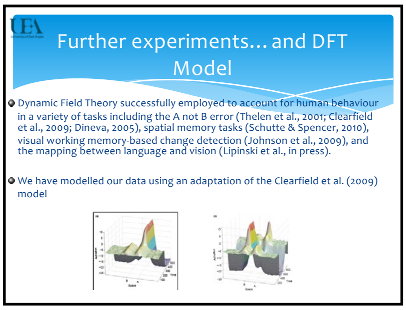

Prime 1 | Prime 2 | Prime 3 | Prime 4 | Probe
1) F F F F F
2) F F F F NF
3) NF NF NF NF NF
4) NF NF NF NF F
158 participants
Randomly allocated to one of 8 conditions: F-F, F-NF, NF-NF and NF-F conditions x hand (afforded versus non-afforded)






Main effect of hand, F(1, 126)=7.7492, p=.00620 and hand by probe association interaction:
probe hand*probe association
F(1, 126)=4.1292, p=.04425
Vertical bars denote 0.95 confidence intervals
probe placement
afforded
non-afforded
probe hand
NF probe
F probe


Expt. 1: Interaction between probe^funct and prime^funct
F(1, 150) = 19.766, p < 0.0001, ηp² = 0.116
Mean normalised placements
incongruent prime-probe
congruent prime-probe
NF
F
PROBE ASSOCIATION


Further experiments… and DFT Model
Dynamic Field Theory successfully employed to account for human behaviour in a variety of tasks including the A not B error (Thelen et al., 2001; Clearfield et al., 2009; Dineva, 2005), spatial memory tasks (Schutte & Spencer, 2010), visual working memory-based change detection (Johnson et al., 2009), and the mapping between language and vision (Lipinski et al., in press).
We have modelled our data using an adaptation of the Clearfield et al. (2009) model

Conclusions

Understanding meaning, broadly construed, involves consideration of three types of relations: S-S, S-V, V-V

How these relations affect meaning judgements also depends on the similarity mapping between input and stored relations.

Adpositions in L2 difficult as they have a high degree of S-S variability.

Our focus should be on learning, rather than on representing meaning in a single way.

- Thank you for your attention!

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