Cognitive Penetrability and the Content of Perception

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Introduction

- Perception is modular; namely, its processes are not influenced by our knowledge, since they are informationally encapsulated (Fodor, 1983; 1988)

- The ‘partial’ theory-ladenness of visual perception: Early and intermediate stages of visual perception are cognitive impenetrable. However, visual perception as a whole is partially cognitive penetrable (Pylyshyn, 1999)

Introduction

- The argument of the cognitive impenetrability as a criterion for nonconceptual content (Raftopoulos & Mueller, 2006)

- I will argue that intermediate stages of visual object representation are directly influenced by cognitive factors; i.e., attention

AND

- The structure of intermediate stages representation, modulated by attention, satisfies, like the structure of conceptual representation, the requirement of systematicity/Generality Constraint (Fodor, 1998; Evans, 1982)

Nonconceptual content

- Weak definition:
  A mental state has a non-conceptual content if and only if the subject of the state needs not to possess the concepts that would be expressed in stating the content of the mental state (Gunther, 2003)

- Strong definition:
  A mental state has nonconceptual content if that mental state has a different kind of content than thoughts, beliefs, etc. (Heck, 2000)

Arguments for nonconceptual content

- “The existence of cognitively impenetrable mechanisms is both a necessary and sufficient condition for nonconceptual content” (Raftopoulos & Mueller, 2006: 190)

- The difference in types of contents between perception and cognition depends on those systems implementing different combinatorial structures (Heck, 2007): Cognitive representations are systematic, perceptual representations are not

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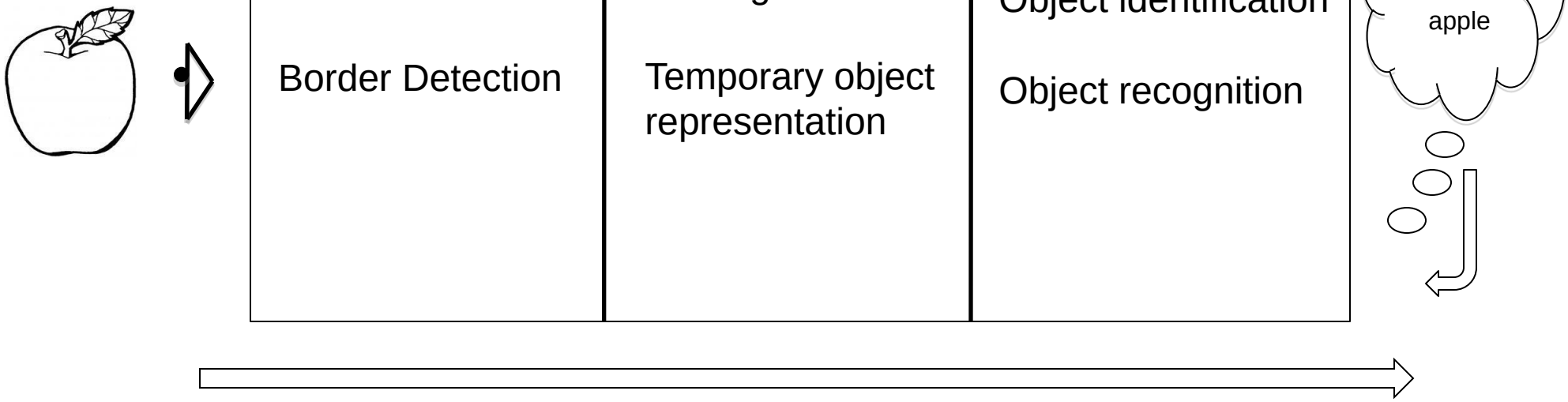
Perception

- Perception: The process that transforms sensations into a representation that can be processed by cognition

- Prima facie, n the relation between perception and cognition there are two directions:

1) Perception provides material for thoughts
2) Cognition selects relevant information out of perception

Perceptual Stages



Marr, 1982; Treisman & Schmidt, 1982

Attention

- The control of attention is an example for cognitive penetrability, since, via attention, a perceiver can alter the way things look to her

- Attention is a selection process, in which some sensory inputs are processed faster or deeper than others, and thus become more readily available for action, memory, or thought (Lamme, 2003)

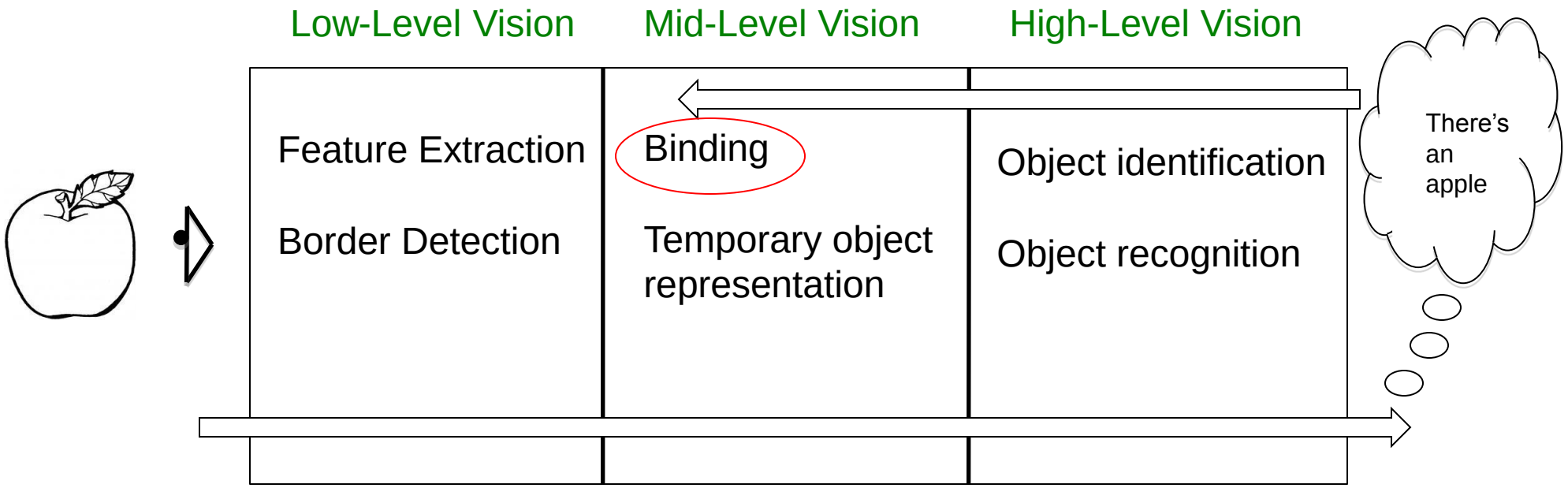
Attention

- Two forms of attention:

  1) ‘grabbed externally’ by salient stimuli → bottom-up attention

  2) endogenous attention that depends on our goals → top-down attention

Perceptual Stages



The binding problem

- Independent researches in psychology (Treisman & Gelade, 1980) and physiology (Zeki, 1978) show that objects are decomposed at early stages of the visual processing. However, we do not perceive single features, but whole objects composed of features

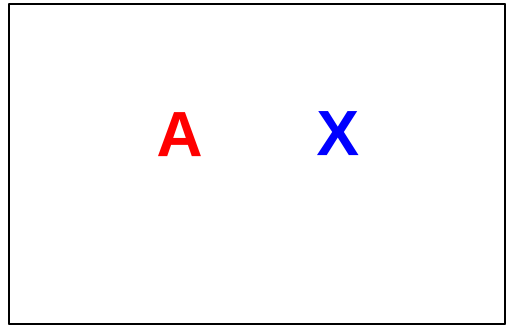
- How does the visual system properly combine features such that a coherent representation of an object results from this recombination?

- Feature Integration Theory (FIT; Treisman, 1993; Robertson, 2003): Spatial attention is the ‘glue’ that binds initially separable features to form a coherent representation of an object

Illusory conjunctions

(Treisman & Schmidt, 1982)

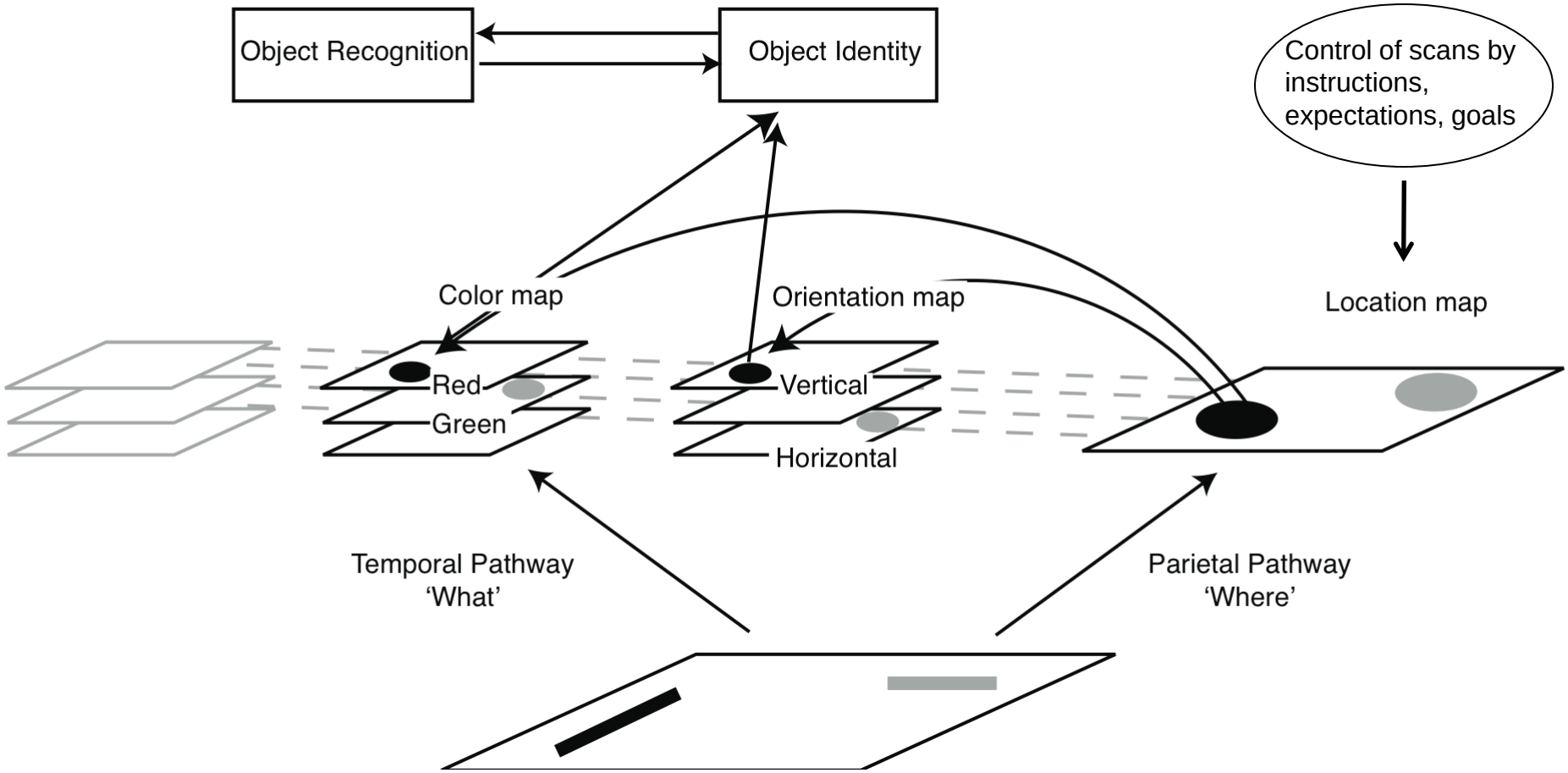
Presented:



Reported:

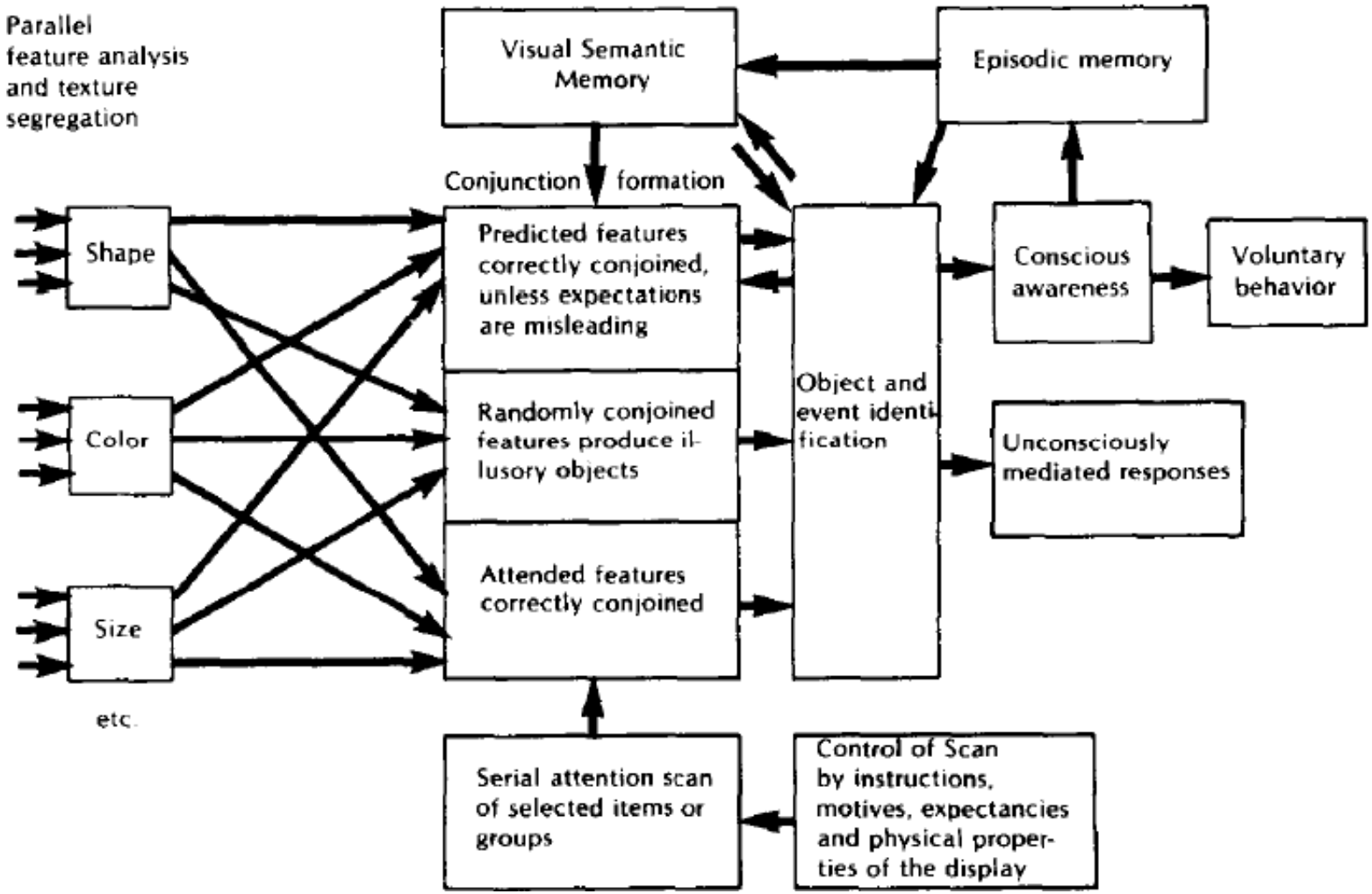
A X

Attention and Binding: FIT



Adapted from Treisman, 1993

Attention and Binding: FIT



(Treisman & Schmidt, 1982)

Summary

- The role of attention in solving the binding problem and in determining the content of our perception reveals the cognitive penetrability of intermediate stages of the visual perceptual processing

- This casts a doubt about the content of representations at intermediate stages to be nonconceptual

The Generality Constraint (GC)

- Generality Constraint (GC; Evans, 1982):

  A subject that can think that a is F and b is G, must also be capable of thinking a is G and b is F

- A weak reading of GC involves that mental states have conceptual content only if they have a systematic structure of constituents
- Systematicity requires that structurally related representations share the same primitive constituents (Fodor and Pylyshyn, 1988)

- (A strong reading of GC involves systematicity + context independence)

GC and nonconceptual content

- The claim that cognitive states have conceptual content should be understood as the claim that the content of those states is structured according to GC (Heck, 2007)

- The debate over nonconceptual content is about whether the systematic structure that underlies the thought ‘the apple is red’ is also at play when one veridically perceives a red apple, and whether it would be impossible to perceive a red apple if this were not the case.

Constituent Structure of Visual Feature Binding

- Visual feature binding is a combinatorial process operating on representations of primitive features (constituents):

  (Red and Vertical) (Green and Horizontal)

- Feature binding has been so described:

$$\frac{\begin{array}{l}\text{At } loc_i \text{ is Red} \\ \text{At } loc_j \text{ is Vertical} \\ loc_i = loc_j\end{array}}{\text{At } loc_i \text{ is both Red and Vertical}}$$

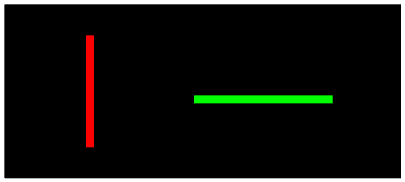
Constituent Structure of Visual Feature Binding

- Features belonging to distinct objects are represented at different locations in the feature maps.
- Attention selects object locations and thereby binds features, resulting in the representation of an integrated object.
- This process is such that whenever object locations are selected the representation of an object and its constituents are tokened simultaneously.
- Hence, visual feature binding has a structure of constituents.

Systematicity of vision

At loc_i is Red
At loc_j is Vertical
$loc_i = loc_j$

At loc_i is both Red and Vertical



At loc_k is Green
At loc_l is Horizontal
$loc_k = loc_l$

At loc_k is both Green and Horizontal

At loc_i is Green
At loc_j is Vertical
$loc_i = loc_j$

At loc_i is both Green and Vertical

At loc_k is Red
At loc_l is Horizontal
$loc_k = loc_l$

At loc_k is both Red and Horizontal

Systematicity of vision

- The description of visual feature binding is mirrored in the neuronal processes underlying visual object representations: Once the same feature is detected, the same feature map is active but at a different location

- Structurally related visual scenes share the same primitive constituents

- The structured recombination underlying visual object representation is nothing over and above the requirement of systematicity

Conceptual content of visual representation

- The structure of visual representations at intermediate stages shares a common property with the structure of cognitive representation; namely, it satisfies the requirement of systematicity/GC

- In a weaker reading of GC, the content of perceptual representation at intermediate stages is conceptual

- However, if one favors a strong reading of GC (like in Heck, 2007), further requirements have to be met for visual representations to have conceptual content

Conclusion

- The visual perceptual system is ‘partially’ theory-laden: Early visual stages are cognitive impenetrable, and their content may be nonconceptual. Intermediate stages are cognitive penetrable, and representations at this stage are structured like cognitive representations.

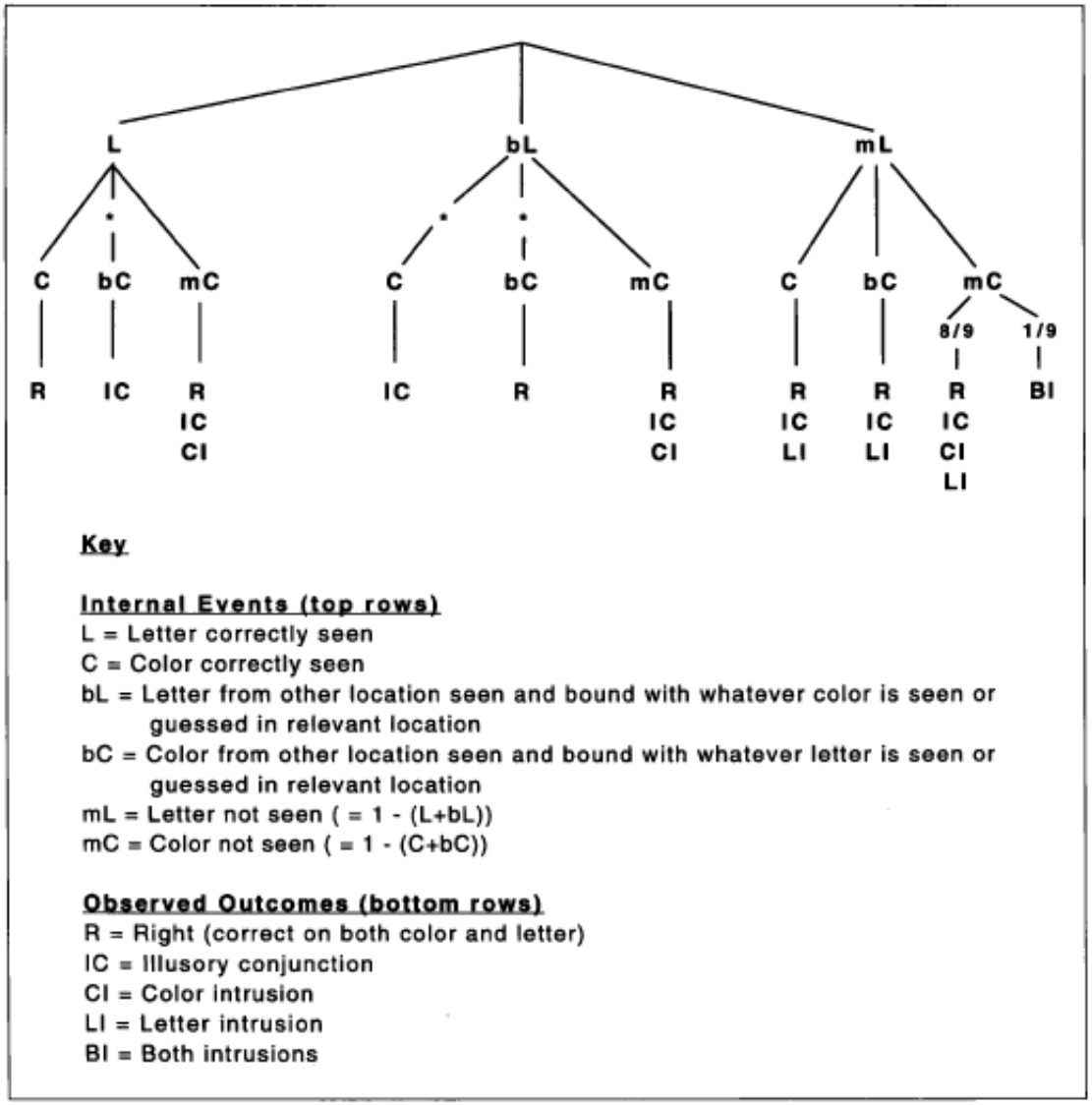


Figure 2. Tree diagram specifying possible combinations of events leading to different responses in report of a colored letter in either of two locations. Observed outcomes are at bottom of tree and internal events are in the top two rows. Asterisks mark branches that represent true binding errors.

Robertson et al., 1997