The Role of Component versus Configural Properties in Face Perception

Rama Amishav

Supervised by Prof. Rutie Kimchi

The Perceptual Relations Between Wholes and Their Component Parts

- Structuralists: Championed the role of elements, claiming that perceptual wholes are constructed by integrating elementary features and components.

- Gestalt psychologists: Emphasized the role of wholes, claiming that “the whole is different from the sum of its parts.”

A whole is qualitatively different from the complex that one might predict by considering only its parts

- A visual object, viewed as a whole, has both component properties or parts and holistic/configural properties and component properties or parts.
- Holistic/configural properties are properties that are defined on the spatial relations between the component parts; they do not inhere in the component parts.
- Empirical question: the relative contribution of component and configural properties.

Face Perception

The holistic view

Faces are perceived and represented as unified, undifferentiated gestalts (e.g., Tanaka & Farah, 1993, 2003).

The configural view

Faces are processed mostly in term of their configural (spatial-relational) properties. Components play a less significant role.

(e.g., Diamond & Carey, 1986; Leder & Bruce, 2000; Maurer et al., 2002; Rhodes et al., 1993; Searcy & Bartlett, 1996).

Dual-mode version: components and configural properties are processed independently; configural coding dominates the processing of upright faces.

Despite intensive research, the relative contribution of analytic and holistic processes to the perception of faces is still under dispute.

Difficulties:

- Lack of clear definitions of the terms “analytic”, “holistic”, and “configural”.
- Scarcity of clear-cut manipulations for assessing configural processing; consequently, inferring configural processing is often indirect.

The Face Inversion Effect (Yin, 1969)

- Refers to the fact that face recognition, unlike the recognition of other objects, is significantly impaired when faces are inverted.
- Suggested account: inversion primarily hinders the encoding of configural properties.
- Most often the critical test for determining whether a manipulation is configural is to examine whether its effect decreases or vanishes following inversion.
- Although intuitively appealing, it is not only indirect, but also circular.

Applying the framework from our former work on object perception (e.g., Kimchi, 1992, 1994, 2003)

- Has led to innovative questions and more direct ways for exploring the relative dominance of component and configural properties in face perception.

- Employ experimental procedures that are not traditionally used in the study of face perception.

The present study

- Examines the relative dominance of components versus configural properties in face perception.

The present study

Definitions and operationlization

- Component properties are defined as the face parts (e.g., shape of eyes, nose, lips).
- Configural properties are defined as the spatial relations between the parts (e.g., the inter-eyes distance).

The present study

Paradigms

- The present study employed three paradigms that allow a direct examination of the relative dominance of component and configural properties in face perception:
  - Face discrimination
  - Garner's speeded classification task
  - The microgenesis of face perception

The discrimination of faces

Experiments 1-3

Does the discriminability of face components predict the discriminability of whole faces?

- Faces vary *only* in components (no configural variability).

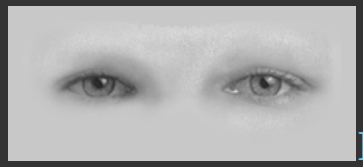
- Faces vary in *both* component and configural properties.

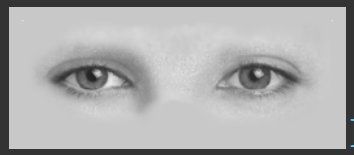
Experiment 1: Isolated components

Eyes


E1


E3


E2


E4

Nose


N3


N4


N1


N2

Lips

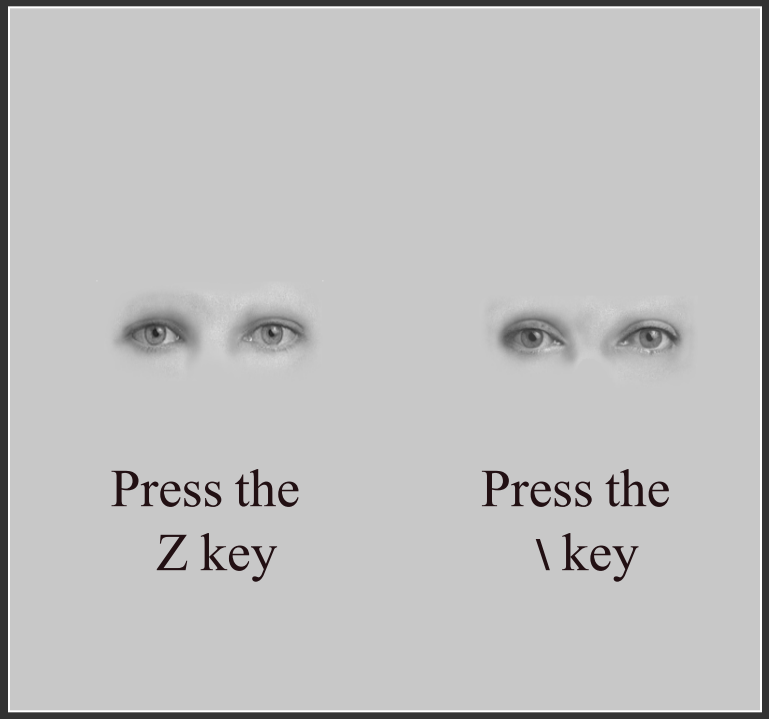

L1

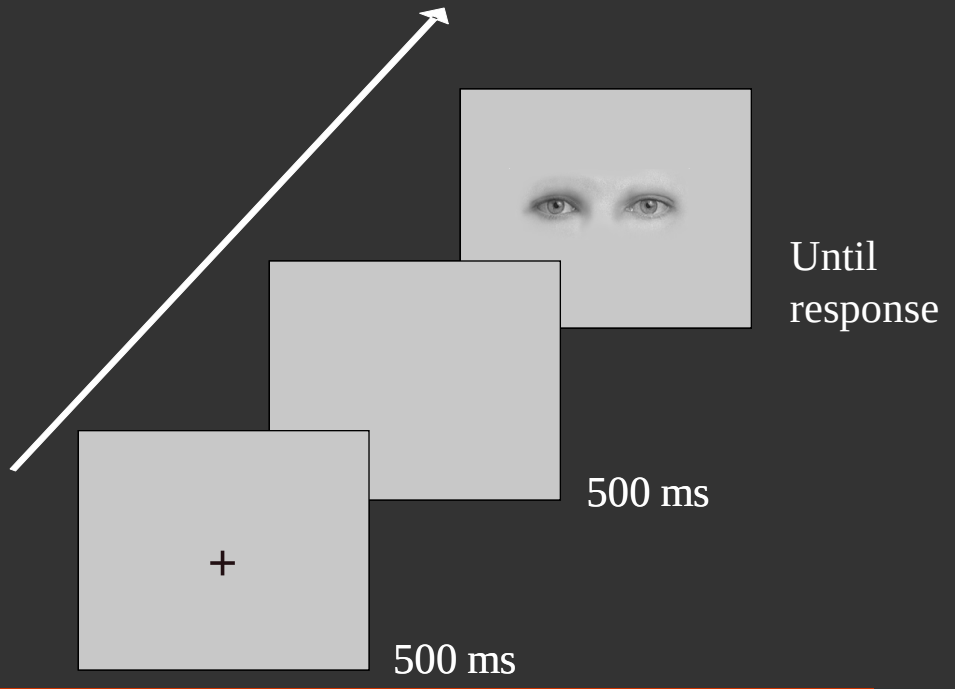

L4


L2


L3

- Six possible discrimination tasks for each type of component.



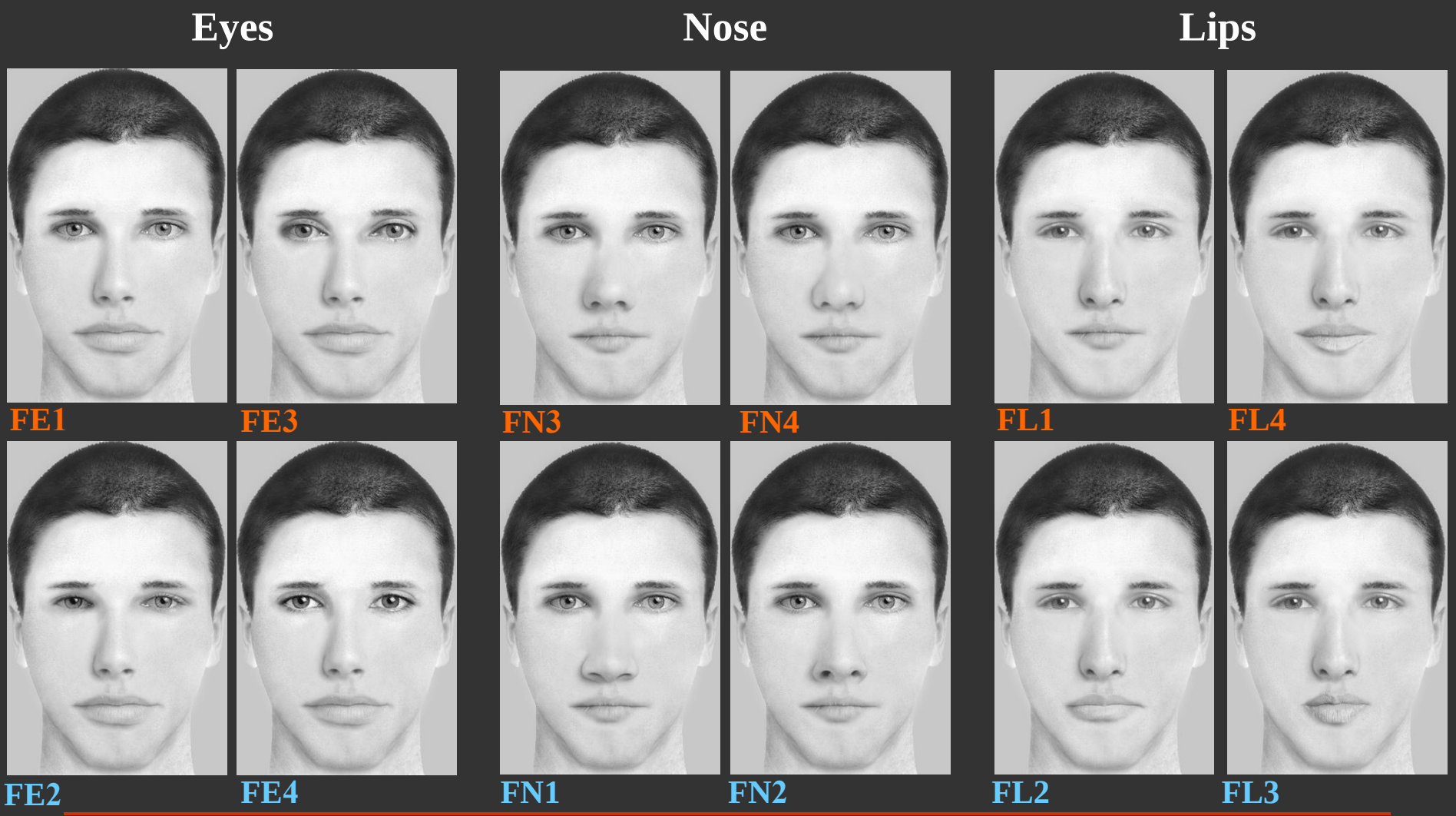


Experiment 1: Results

EYES		*NOSE*		*LIPS*	
Task	**RT (ER)**	**Task**	**RT (ER)**	**Task**	**RT (ER)**
E1-E3	799 (4)	N3-N4	827 (7)	L1-L4	721 (3)
E1-E2	759 (2)	N2-N3	798 (4)	L2-L4	702 (2)
E3-E4	740 (3)	N1-N4	749 (4)	L3-L4	685 (3)
E1-E4	738 (2)	N2-N4	736 (2)	L1-L2	680 (1)
E2-E3	689 (2)	N1-N3	721 (3)	L1-L3	658 (2)
E2-E4	681 (2)	N1-N2	719 (2)	L2-L3	652 (1)
Mean	*734(2.5)*	*Mean*	*758(3.6)*	*Mean*	*683(2)*

Red notations: least discriminable. Blue notations: most discriminable.

Experiment 2a: Faces that differ in one component



Isolated Components

EYES		*NOSE*		*LIPS*	
Task	**RT (ER)**	**Task**	**RT (ER)**	**Task**	**RT (ER)**
E1-E3	799 (4)	N3-N4	827 (7)	L1-L4	721 (3)
E1-E2	759 (2)	N2-N3	798 (4)	L2-L4	702 (2)
E3-E4	740 (3)	N1-N4	749 (4)	L3-L4	685 (3)
E1-E4	738 (2)	N2-N4	736 (2)	L1-L2	680 (1)
E2-E3	689 (2)	N1-N3	721 (3)	L1-L3	658 (2)
E2-E4	681 (2)	N1-N2	719 (2)	L2-L3	652 (1)
Mean	*734(2.5)*	*Mean*	*758(3.6)*	*Mean*	*683(2)*

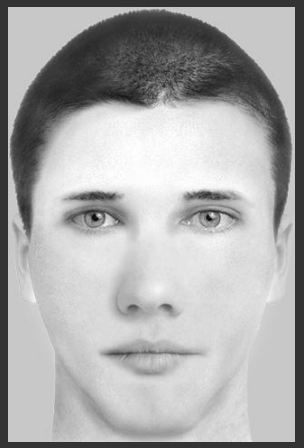
Components in Faces

EYES		*NOSE*		*LIPS*	
Task	**RT (ER)**	**Task**	**RT (ER)**	**Task**	**RT (ER)**
FE1-FE3	808 (7)	FN3-FN4	877 (4)	FL2-FL4	741 (3)
FE3-FE4	788 (5)	FN2-FN4	838 (3)	FL1-FL4	739 (1)
FE1-FE2	743 (3)	FN2-FN3	830 (2)	FL1-FL3	732 (2)
FE1-FE4	740 (3)	FN1-FN4	826 (3)	FL3-FL4	722 (1)
FE2-FE3	716 (2)	FN1-FN3	812 (2)	FL1-FL2	716 (2)
FE2-FE4	706 (3)	FN1-FN2	788 (3)	FL2-FL3	681 (0)
Mean	*750(4)*	*Mean*	*828(3)*	*Mean*	*722(2)*

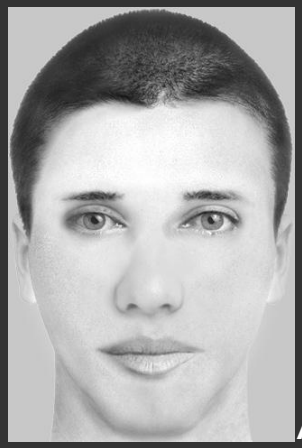
Red notations: least discriminable. Blue notations: most discriminable.

Experiment 2b: Faces that differ in all components

Components



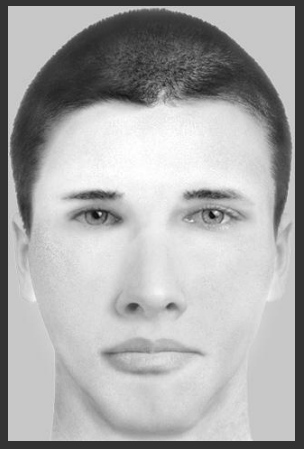
E1N3L1



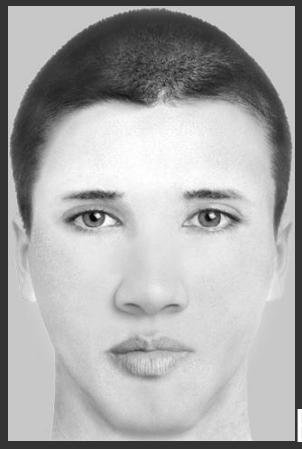
E3N4L4

A

Least discriminable



E2N2L2



E4N1L3

B

Most discriminable

Results

		Eyes	Nose	Lips	Eyes+Nose+Lips
Task		RT (ER)	RT (ER)	RT (ER)	RT (ER)
Least discriminable	Isolated	799 (4)	827 (7)	721 (3)	830 (2)
Most discriminable	Isolated	681 (2)	719 (2)	652 (1)	719 (1)

- Discrimination of faces differing in the least discriminable components was slower than faces differing in the most discriminable components.
- The discrimination of faces differing in all components was as slow as the most difficult component.

Experiments 1 & 2

Conclusions

- The discrimination of isolated components predicts the discrimination of whole faces that differ only in those components, all else being equal.
- Adding a context of a face does not facilitate discrimination.
- Exhaustive processing of all components.

Experiment 3

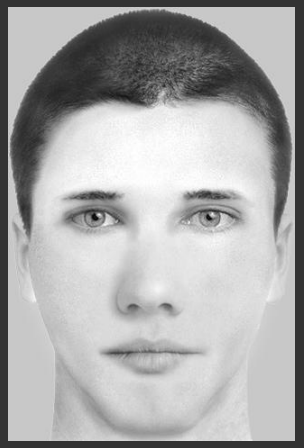
Objective

- Compare between the discrimination of faces that vary only in component properties vs. faces that vary in *both* component and configural properties.

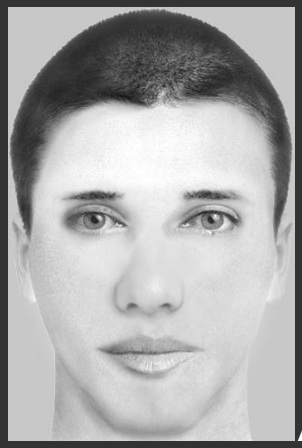
- If the discrimination of faces that differ in configural properties is easier than between faces that have similar configural properties, *regardless* of the discriminability of the components, it would indicate the relative dominance of configural properties.

Components

Components + Configural

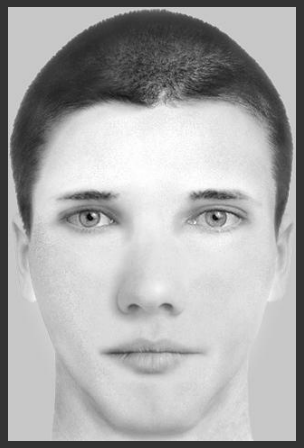


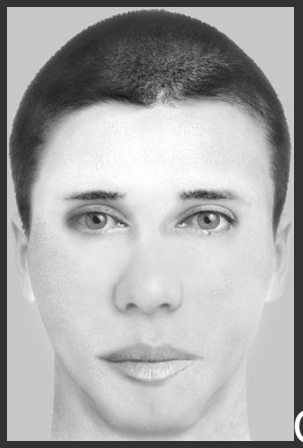
E1N3L1



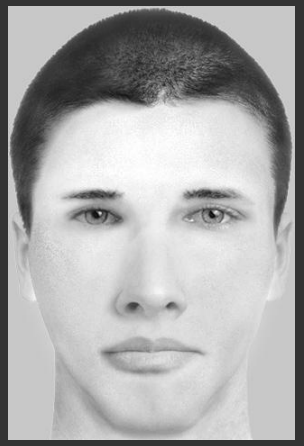
E3N4L4

A

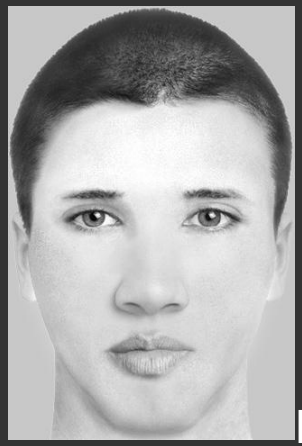




C

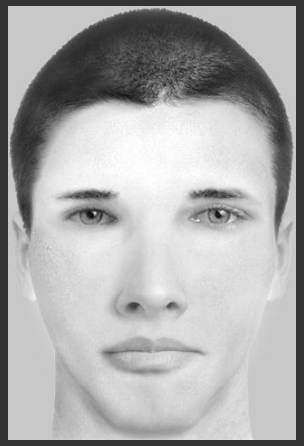


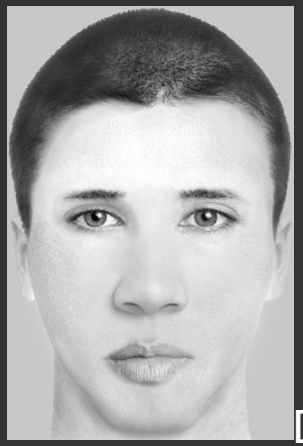
E4N1L3



E2N2L2

B



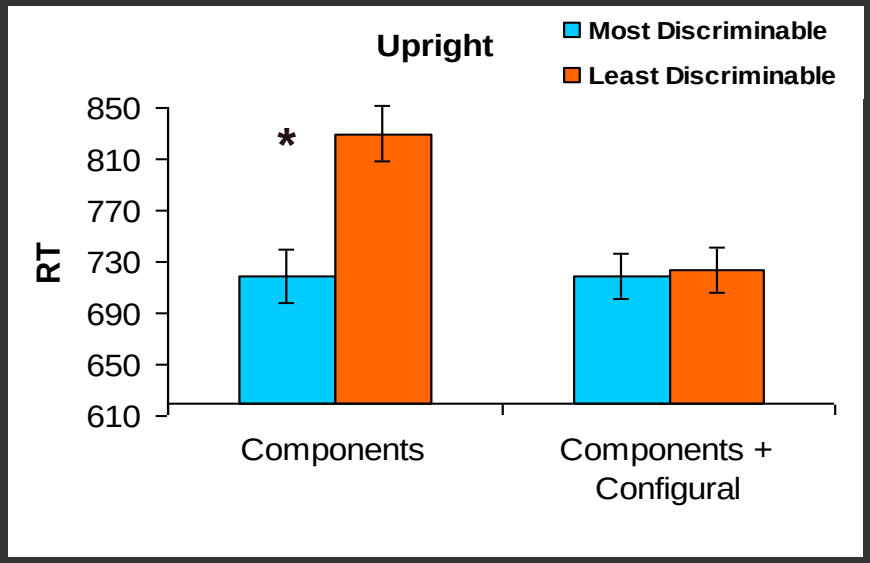


D

Top row: least discriminable components. Bottom row: most discriminable components.

Components: discrimination of faces differing in the least discriminable components was slower than faces differing in the most discriminable components.

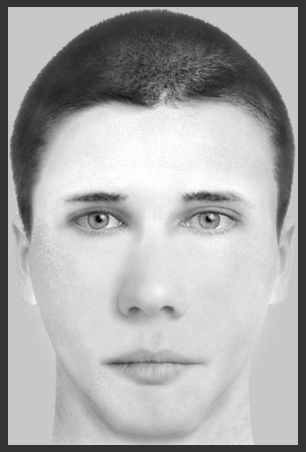
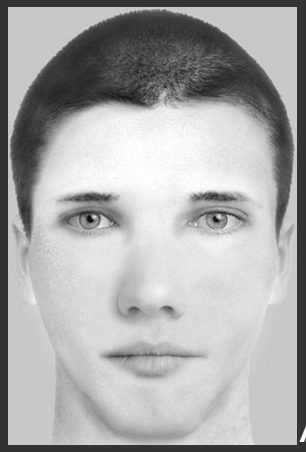
Components + Configural: the difference vanishes, and performance is facilitated for the faces differing in the least discriminable components.



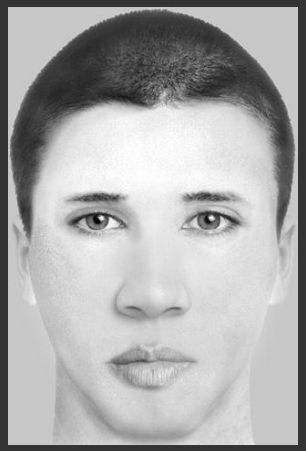
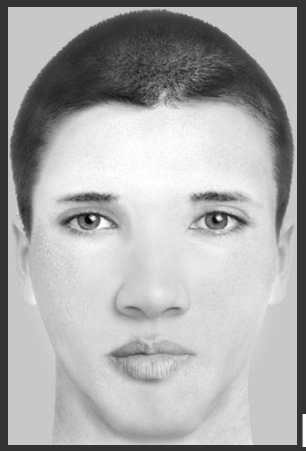
Can these findings be attributed to:

1) A stronger salience of the configural properties vs. the components?
2) Increased dissimilarity of faces in the components + configural condition?

Faces that differ only in configural properties

A

B

	Upright	Inverted
	RT (ER)	RT (ER)
Overall	825 (7)	833 (9)

The configural properties employed are difficult to discriminate in themselves.

The marked facilitation suggests an interaction between configural and component properties.

		Eyes	Nose	Lips	Eyes+Nose+Lips
Task		RT (ER)	RT (ER)	RT (ER)	RT (ER)
Least discriminable	In face	808 (4)	877 (4)	739 (1)	830 (2)
Most discriminable	In face	706 (3)	788 (3)	681 (1)	719 (1)

Increased dissimilarity *per se* does not facilitate performance.

Experiments 1-3

Conclusions

- When only components vary, face discrimination is determined by the discriminability of the components.
- Exhaustive processing of all components.*
- When faces also vary in configural properties, discrimination is no longer predicted by the discriminability of the components.
- Configural properties may be particularly important under conditions in which discrimination by components is difficult.
- Suggestive of an interaction between components and configural properties.

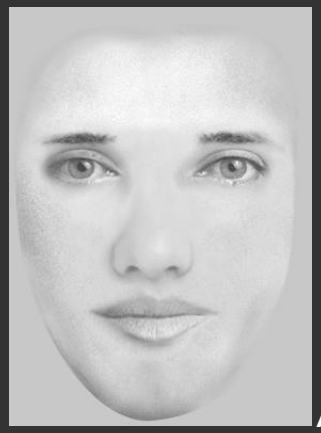
Garner's speeded classification task

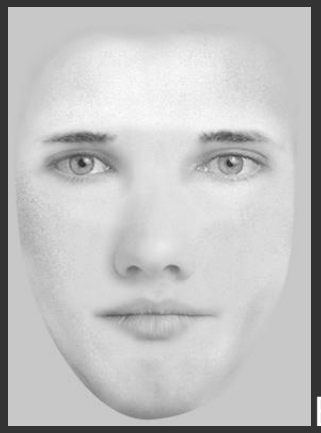
Experiment 4

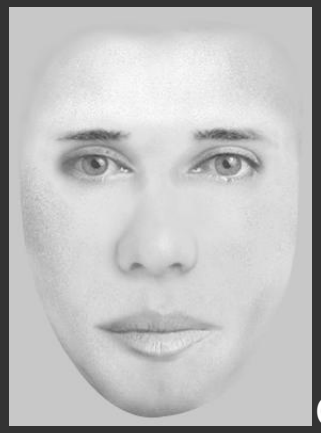
- Examined the relative dominance of components and configural properties in the context of selective attention.
- Garner's speeded classification task (Garner, 1974) was employed.

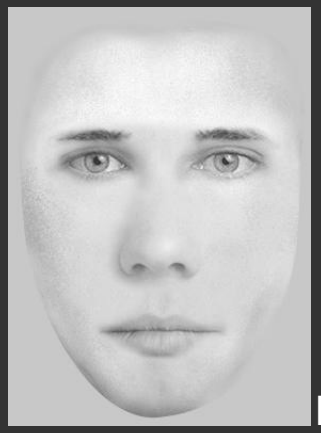
Selective attention to one dimension, while another irrelevant dimension:

- remains constant (control)
- varies orthogonally (filtering)


A


B

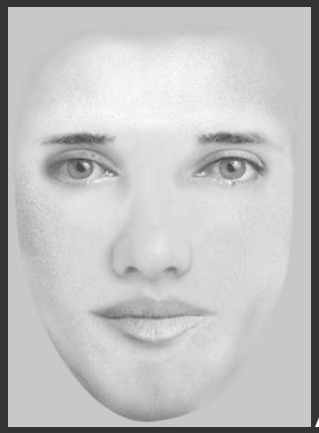

C

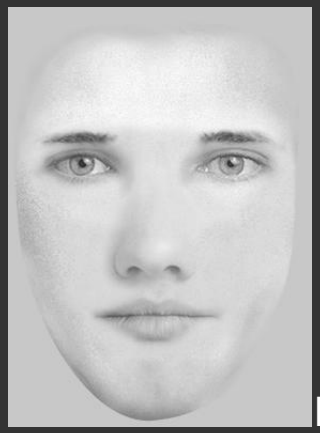

D

RT Filtering = RT Control → perceptual independence of the two dimensions.

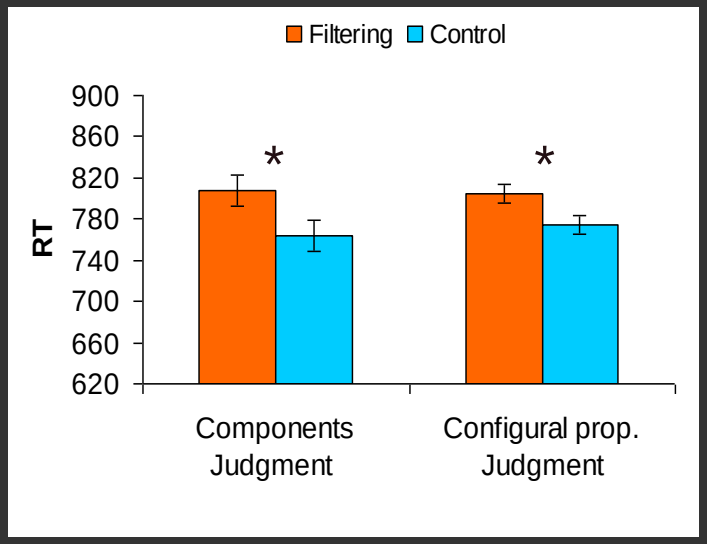
RT Filtering > RT Control → perceptual dependence of the two dimensions (*Garner's interference*).

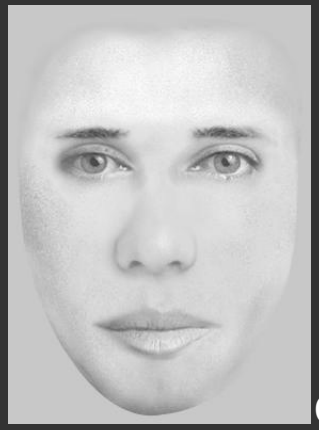
Selective attention to components or configural properties

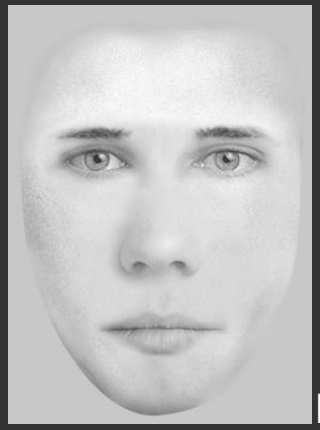

A


B

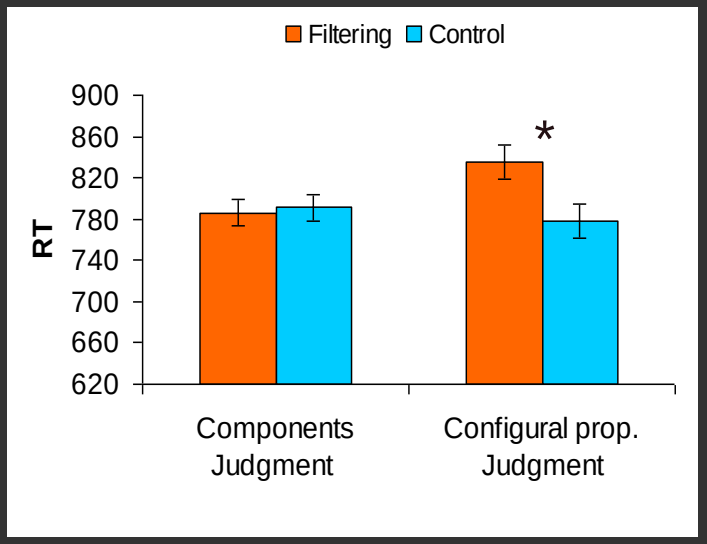
Upright




C


D

Inverted



Experiment 4

Conclusions

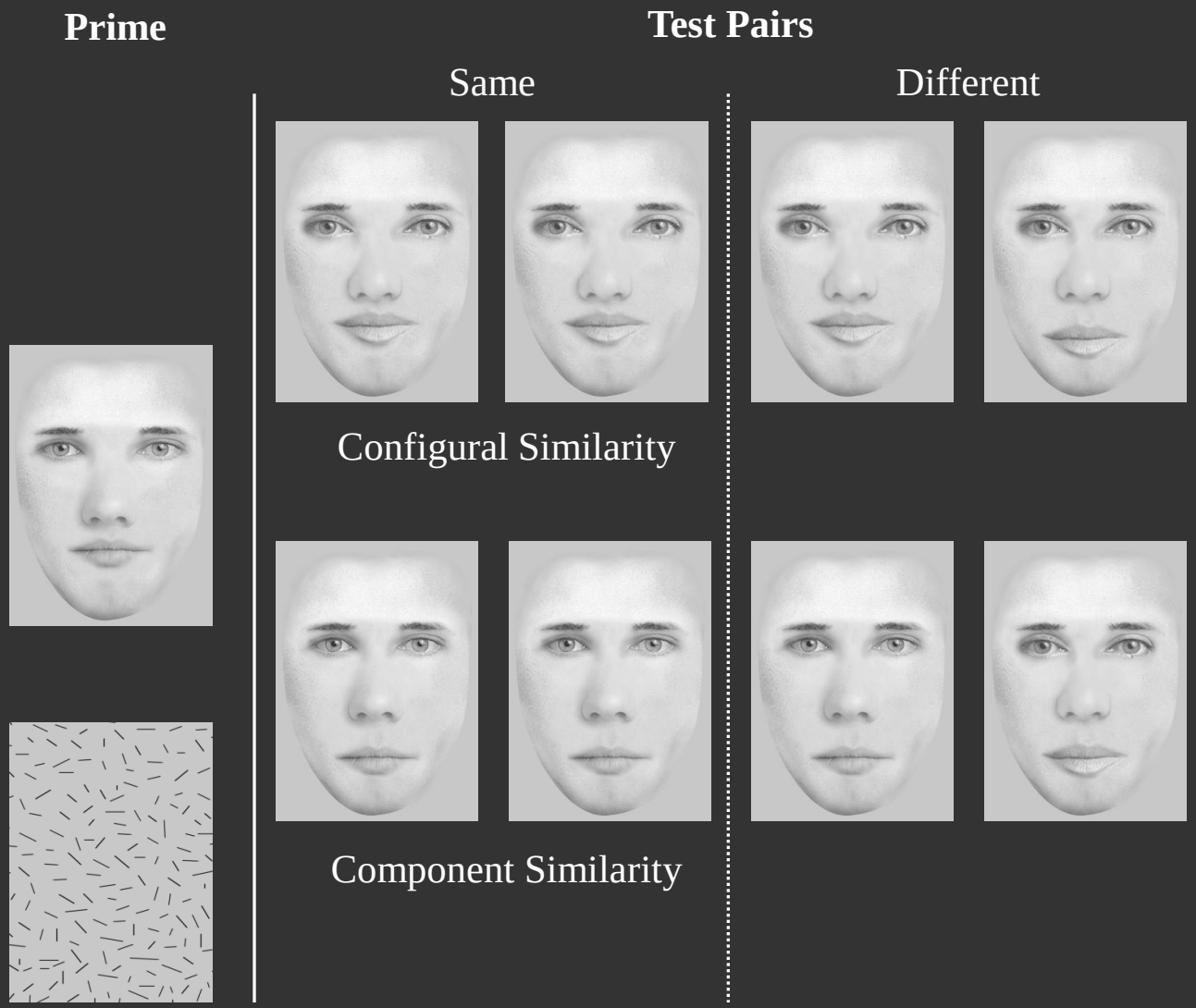
- Component and configural properties interact in the perception of upright faces: It is not possible to selectively attend to the components while ignoring irrelevant variations in configural properties, and vice versa.
- Inverted faces are dominated by the processing of component properties.

Experiment 5

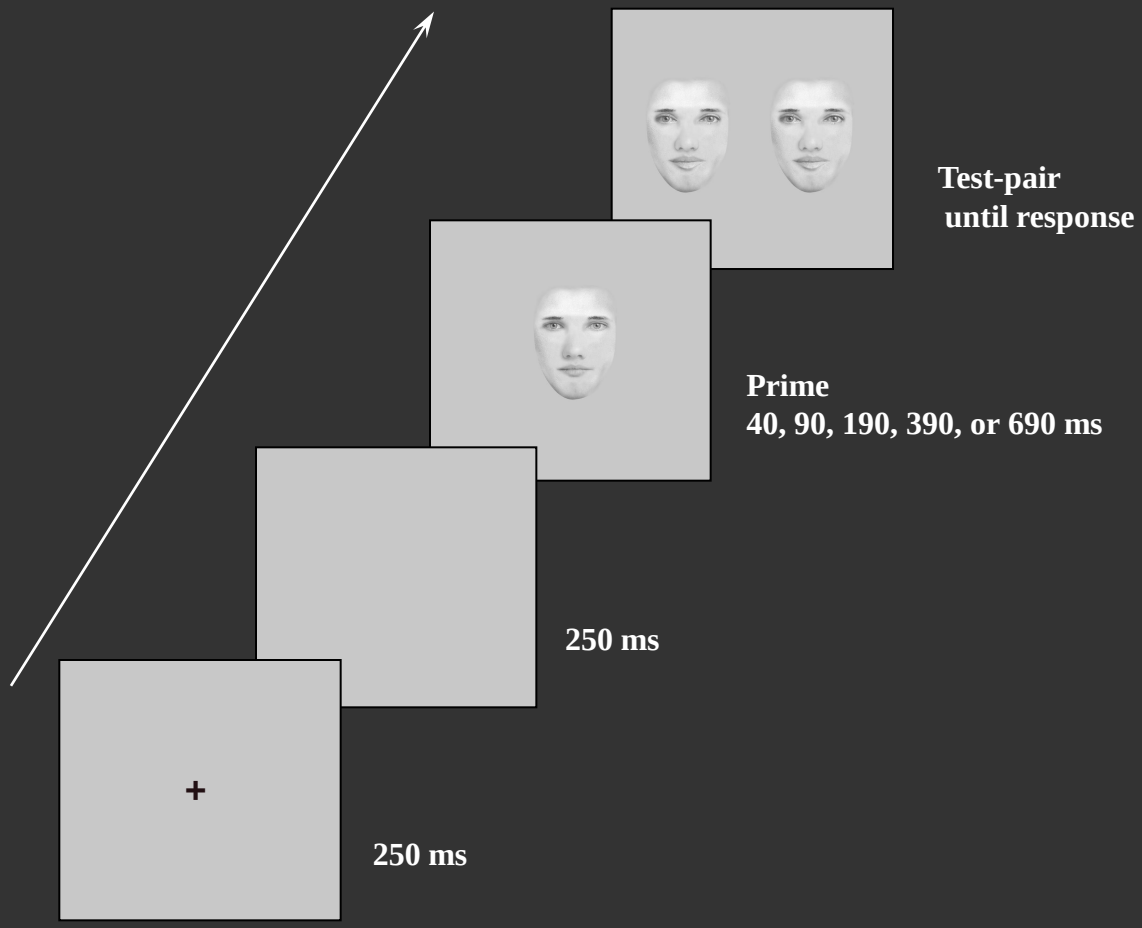
Microgenesis of face representations

- Examined the relative dominance of configural vs. component properties in the evolution of the percept of a face, using the primed-matching paradigm (e.g., Kimchi, 1998).

Stimuli


Prime
Test Pairs
Same
Different
Configural Similarity
Component Similarity

Sequence of events in a trial



Priming measure

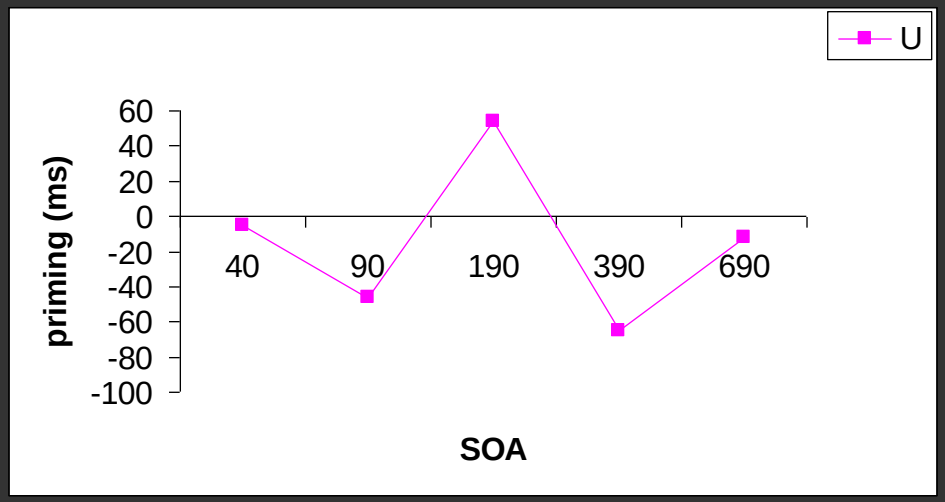
Priming =

[RT(component similarity/prime) – RT(configural similarity/prime)] –

[RT(component similarity/control) – RT(configural similarity/control)]

priming values > 0 → priming of configural properties
priming values < 0 → priming of components

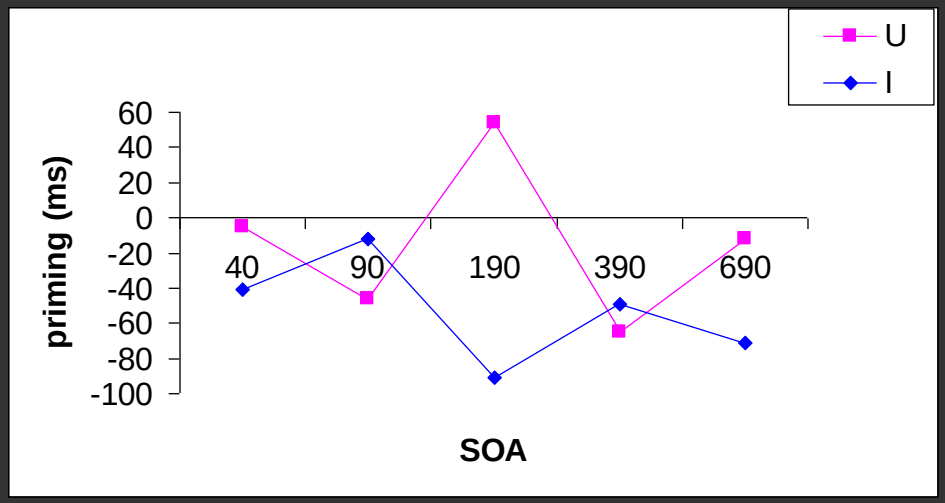
Results: Upright



priming values > 0 → priming of configural properties

priming values < 0 → priming of components

Results: Upright and inverted



priming values > 0 → priming of configural properties

priming values < 0 → priming of components

Experiment 5

Conclusions

- The microgenesis of upright and inverted faces follows different paths.
- ***Upright*****.** Initial tendency for priming of components (albeit not significant) is followed by priming of configural properties (190 ms), which turns into priming of components (390 ms). Only later, both types of properties seem to be equally available (690 ms).
- ***Inverted.*** Relative dominance of component properties is observed throughout the time course.

Summary

- By employing three different paradigms that allow a direct examination of the relative dominance of component versus configural properties, our results converge in demonstrating that component and configural properties interact in the perception of upright faces.

Summary

- Our findings divert from:
  - The holistic approach, which suggests that faces are processed as undifferentiated gestalts;
  - The configural approach, in particular the dual-mode view, which suggests that components and configural properties are processed independently, and that configural properties dominate face perception.
- Rather, our findings indicate that it is the mutual perceptual interaction between component and configural properties that is the hallmark of face perception.

Thanks to

Prof. Rutie Kimchi

IIPDM staff

- *Rachel Kaverman*
- *Hana Struminger*
- *Etti Levran (Merkin)*
- *Anna Vedenichev*
- *Baruch Kaplan*

Research Assistants

- *Allegra Dan*
- *Rony Raz*
- *Ruthy Peled*

Background

The holistic approach

Faces are perceived and represented as unified gestalts (e.g., Tanaka & Farah, 1993, 2003).

The configural approach

Faces are processed mostly in term of their configural (spatial-relational) properties. Components play a less significant role.

(e.g., Diamond & Carey, 1986; Leder & Bruce, 2000; Maurer et al., 2002; Rhodes et al., 1993; Searcy & Bartlett, 1996).

Some authors claim that componential and configual processing constitute dual routes: configural coding dominates face processing, while components dominate the processing of inverted faces.

The present approach

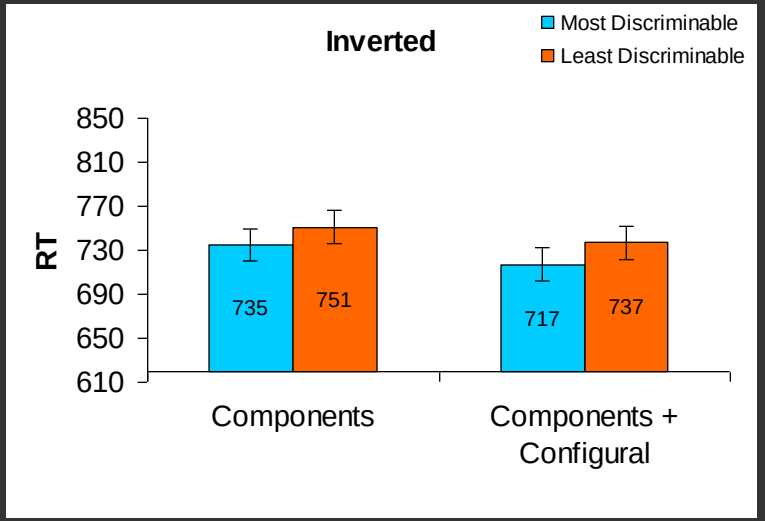
- Originates from former work on object perception (e.g., Kimchi, 1992, 1994, 2003).
- Employs experimental procedures that are not traditionally used in the study of face perception.

- A whole is qualitatively different from the complex that one might predict by considering only its parts.

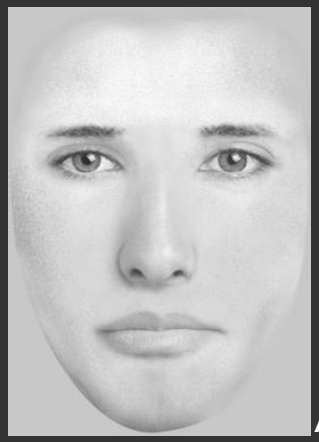
- The relations between components matter, and may dominate processing.

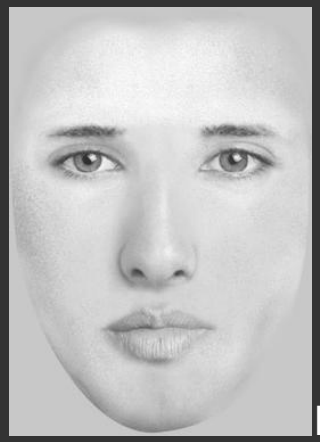
Inverted

Discrimination is dominated by the most discriminable component (i.e., the lips), suggesting the extraction of individual components.

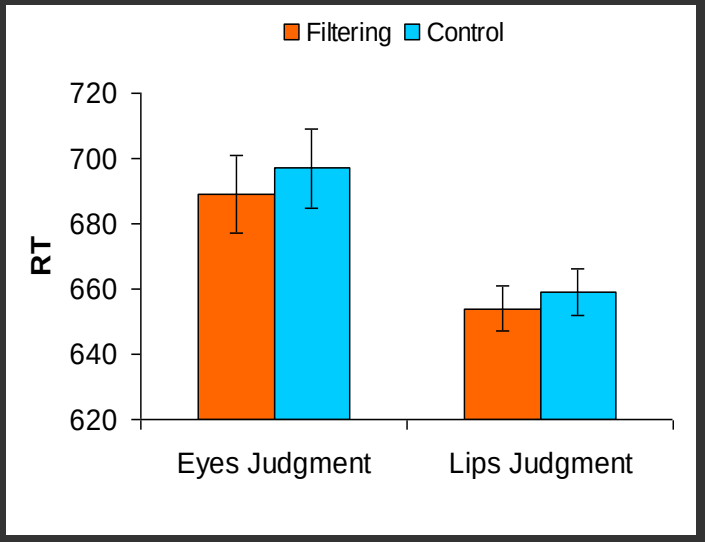


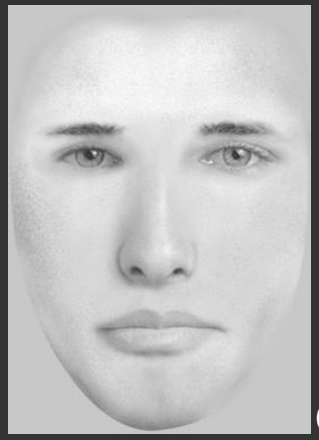
Experiment 4: Selective attention to components

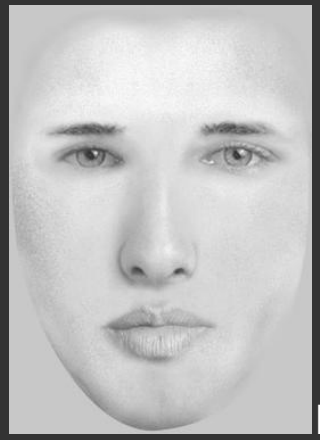

A


B

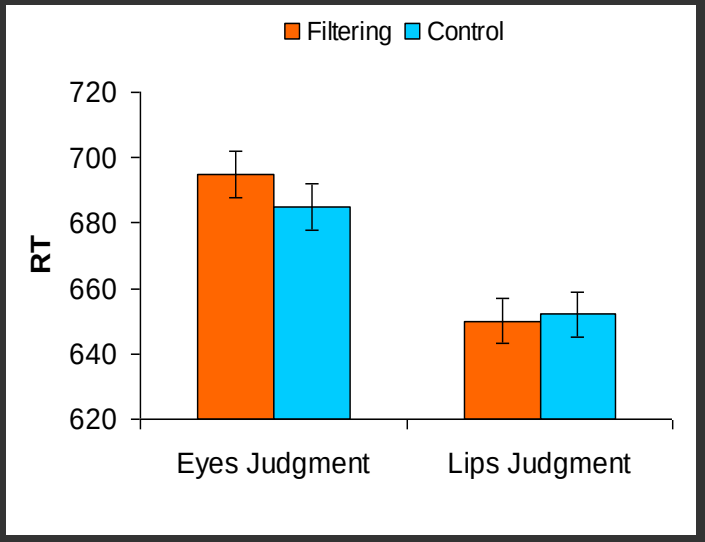
Upright



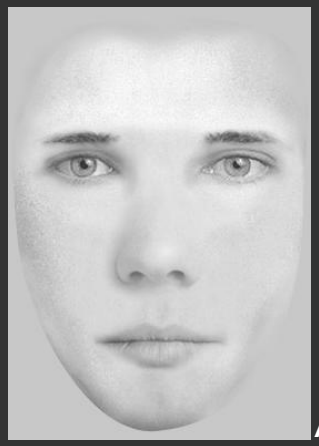

C

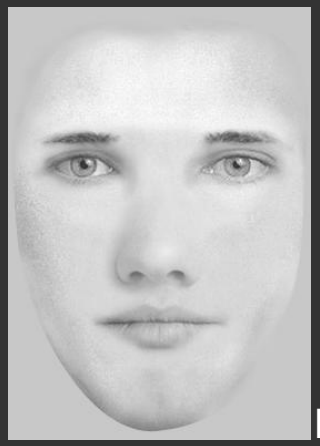

D

Inverted

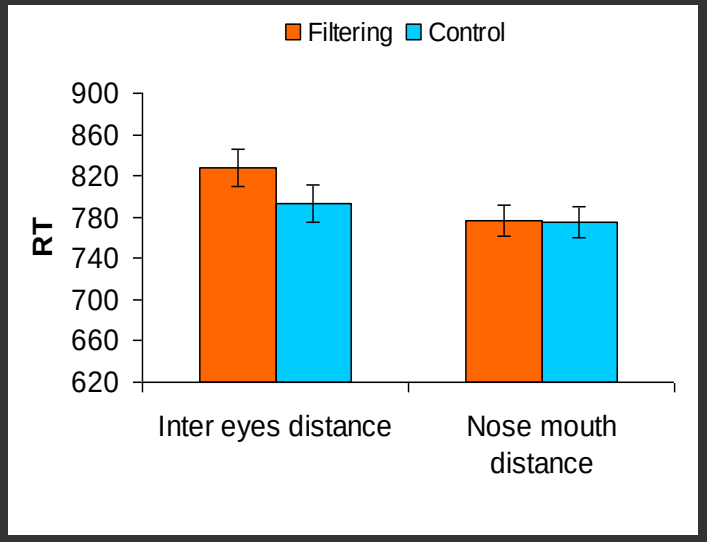


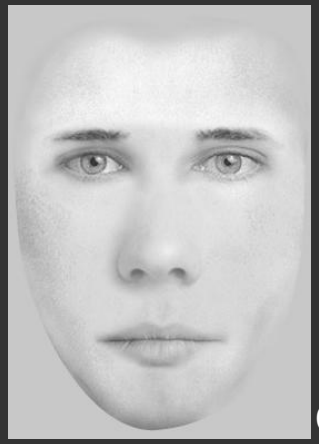
Experiment 5: Selective attention to configural properties

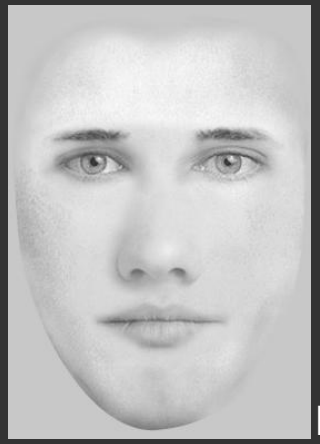

A


B

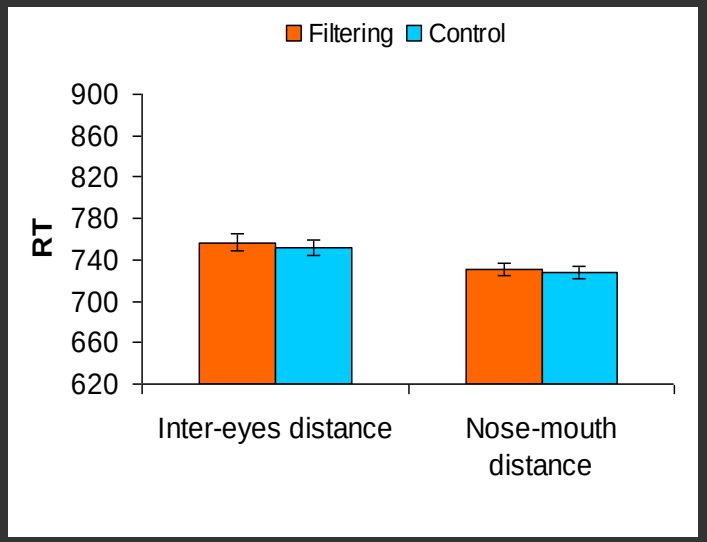
Upright




C


D

Inverted



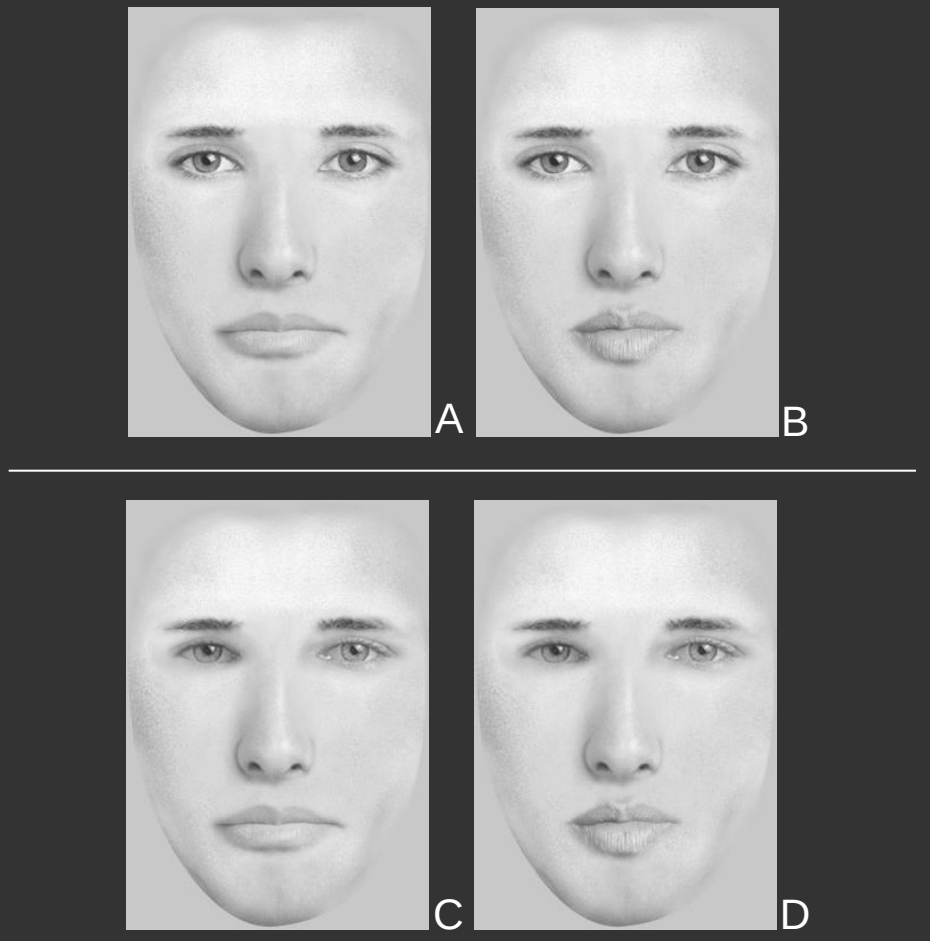
Experiments 4-6

Conclusions

- Components appear to be perceptually independent: Selective attention to one component, while ignoring variations in another, is possible.
- Although perceivers' default may be to process all facial components exhaustively (Experiments 1-3), they can nevertheless selectively attend to specific facial components when task calls for it.

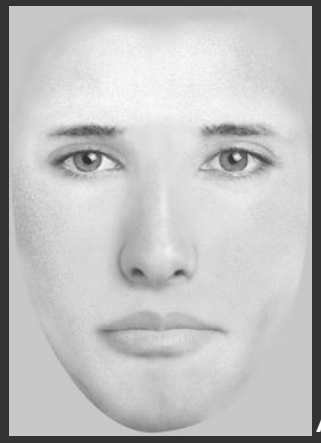
Garner's speeded classification task

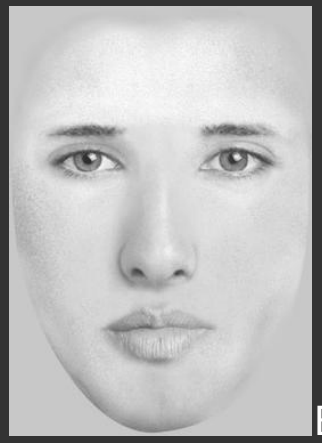
Control condition
for the lips judgment

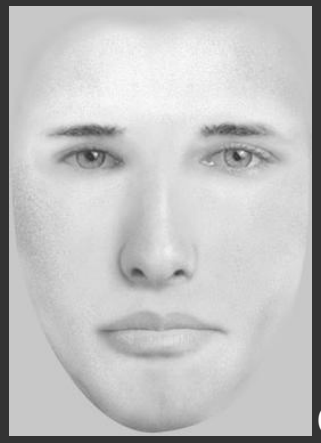


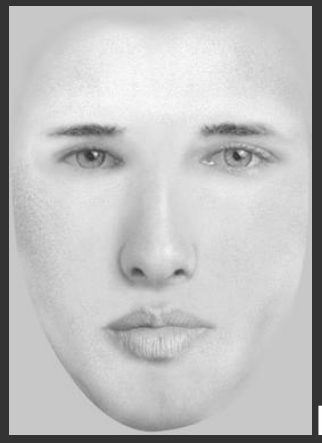
Garner's speeded classification task

Filtering condition
for the lips judgment


A


B


C


D