Report

# Opposite Modulation of High- and Low-Level Visual Aftereffects by Perceptual Grouping

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## Summary

A fundamental task of visual perception is to group visual features—sometimes spatially separated and partially occluded—into coherent, unified representations of objects. Perceptual grouping can vastly simplify the description of a visual scene and is critical for our visual system to understand the three-dimensional visual world. Numerous neurophysiological and brain imaging studies have demonstrated that neural mechanisms of perceptual grouping are characterized by the enhancement of neural responses throughout the visual processing hierarchy, from lower visual areas processing grouped features to higher visual areas representing objects and shapes from grouping [1–3]. In a series of psychophysical adaptation experiments, we made the counterintuitive observation that perceptual grouping amplified the shape aftereffect but meanwhile, reduced the tilt aftereffect and the threshold elevation aftereffect (TEAE). Furthermore, the modulation of perceptual grouping on the TEAE showed a partial interocular transfer. This finding suggests a 2-fold effect of perceptual grouping—enhancing the high-level shape representation and attenuating the low-level feature representation even at a monocular level. We propose that this effect is a functional manifestation of a predictive coding scheme [4–8] and reflects an efficient code of visual information across lower and higher visual cortical areas.

## Results

[illegible] [9–11].

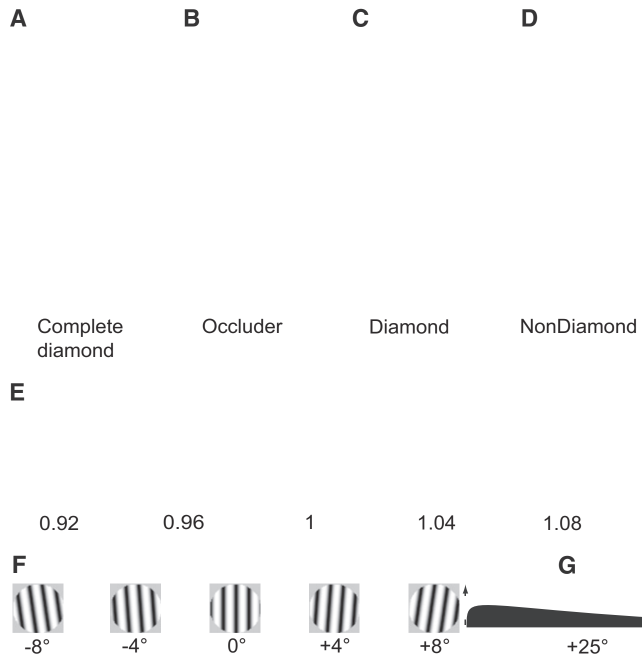
[illegible] (Figure 1). [illegible]

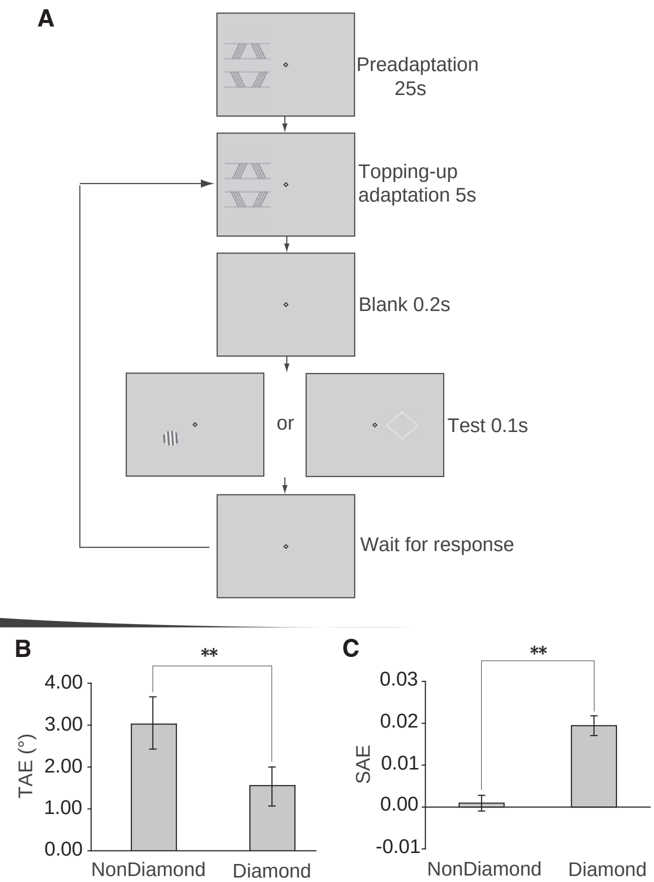
(Figure 1A) [illegible] (Figure 1B). [illegible] (Figure 1C). [illegible] [12]. [illegible] 0.6° [illegible] (Figure 1D). [illegible] 93% [illegible] (3% [illegible]). [illegible] [13]. [illegible] MRI [illegible] [14, 15] [illegible] V1. [illegible]

### Effect of Perceptual Grouping on Shape Aftereffect and Tilt Aftereffect

[illegible] 1, [illegible] (SAE) [illegible] (TAE) [illegible] (Figure 2A). [illegible] (2-AFC) [illegible] (Figure 1E) [illegible] SAE, [illegible] (Figure 1F) [illegible] TAE, [illegible]

*[illegible]




F[illegible] 2. P[illegible] R[illegible] E[illegible] 1

(A) E[illegible] . A [illegible] 25 [illegible] 5 [illegible] 0.2 [illegible] 0.1 [illegible] 2-AFC [illegible]. T[illegible] TAE, [illegible] SAE, [illegible].

(B) TAE [illegible].

(C) SAE [illegible]. A [illegible] (*$p$ < 0.05; **$p$ < 0.01). E[illegible] ba[illegible] 1 SEM [illegible].

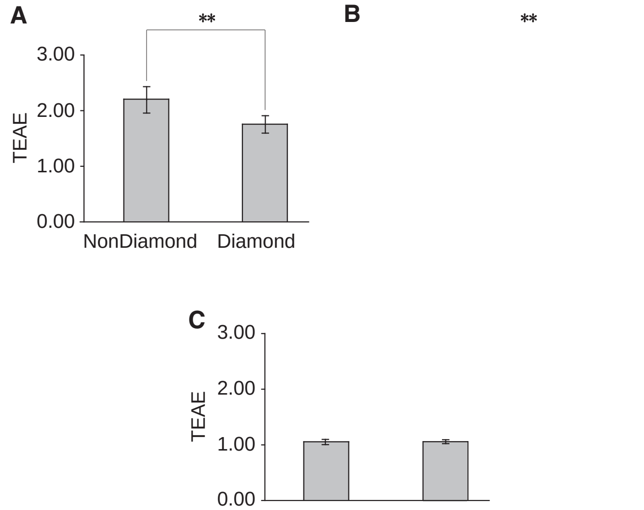
[illegible] TAE [illegible] SAE [illegible]. I [illegible] TAE [illegible] / [illegible] SAE, [illegible] / [illegible].

F[illegible] ± SEM) [illegible] 1.84° ± 0.76°, 3.31° ± 0.90°, [illegible] 0.29° ± 0.72°, [illegible]. TAE [illegible] ( = 4.90, $p$ < 0.01) [illegible] ( = 3.31, $p$ < 0.05). T[illegible] TAE [illegible] ( = 6.85, $p$ < 0.01) (F[illegible] 2B). H[illegible], SAE [illegible] 0.9937 ± 0.009, 0.9752 ± 0.01, [illegible] 0.9743 ± 0.01 [illegible]. A[illegible] SAE [illegible] ( = 8.21, $p$ < 0.01), [illegible] ( = 0.49, $p$ > 0.05). T[illegible] ( = 5.07, $p$ < 0.01) (F[illegible] 2C). T[illegible]

ba[illegible]. T[illegible] SAE [illegible]. A[illegible] (LO) [illegible] LO [illegible] [16], [illegible] [17].

## Effect of Perceptual Grouping on Threshold Elevation Aftereffect

I[illegible] 1, [illegible] TAE [illegible]




... a ... a ... - ... (F... 3C). T ... a ... ba... a ...

F ... (TEAE). A ... TAE ... b ... a ... (TEAE) a b ... a ... [18]. T ... [19 21].

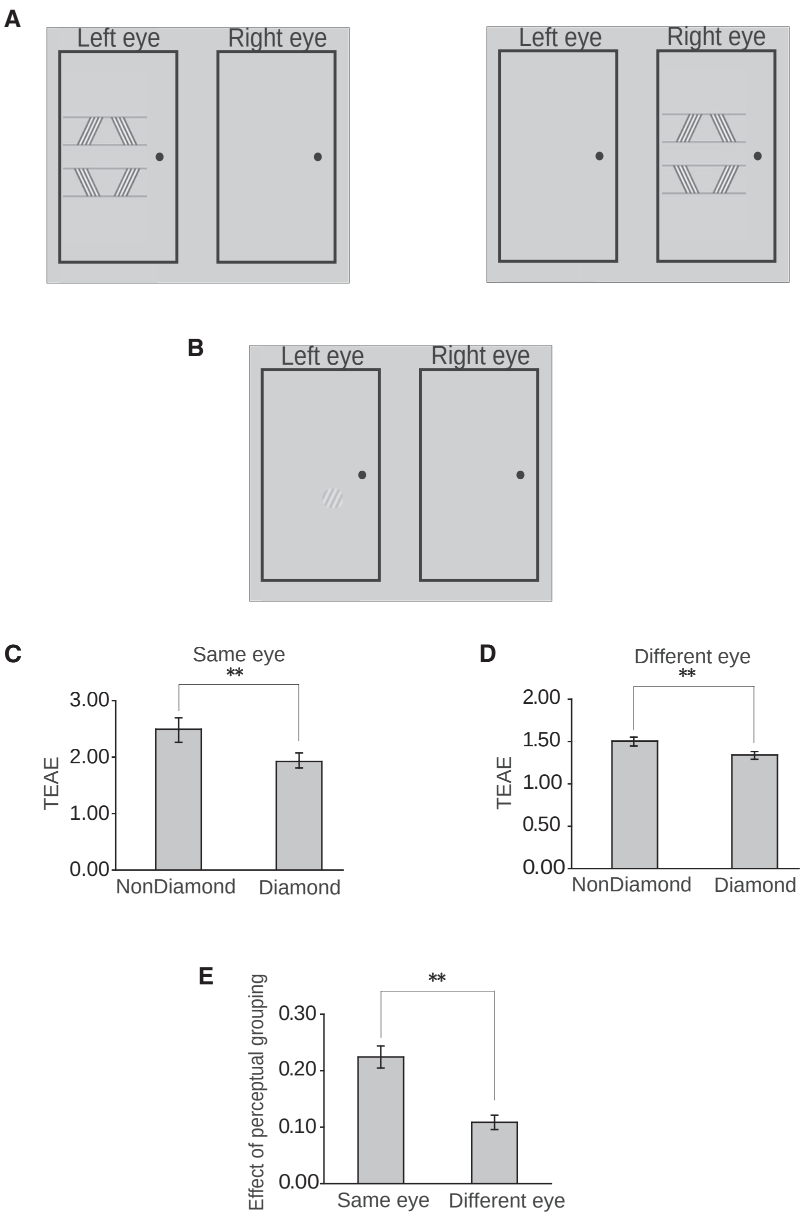
E ... 2 ... TEAE a ... SAE ... TEAE ... 2-AFC QUEST ... (82% ...) [22] ... TEAE ... (e.g., ... ba...) (F... 1G). W ... TEAE a ... ( = 9.31, p < 0.01) a ... ( = 11.21, p < 0.01). T TEAE ... ( = 5.02, p < 0.01) (F... 3A). T SAE ... 1 a ... (F... 3B). I ... TEAE ... N ... a ...

## Interocular Transfer of Perceptual Grouping Effect

B ... TAE a ... TEAE a... V1 ( ... TEAE) [20, 23], ... a ... ba... a ... T ... V1 ... 2 (e.g., TEAE ...), ... 3 ... TEAE ... T TEAE ... 2 ... S...bj ... (F... 4A). T ... (F... 4B). W ... TEAE ... (*1- TEAE from adapting to the diamond/TEAE from adapting to the nondiamond*). A ... I ... A 100% ... A ... I ... [24] (b... [25]).

R ... TEAE a ... ( ... : = 11.46, p < 0.01; ... : = 28.60, p < 0.01) a ... ( ... : = 14.43, p < 0.01; ... : = 29.46, p < 0.01). T TEAE ... ( ... : = 6.46, p < 0.01; ... : = 8.01, p < 0.01) (F... 4C a... 4D). T ... 2. A ... TEAE ... ( = 7.79, p < 0.01). T ... 0.22 a... 0.11, ... (F... 4E). T ... 48.4%, ... A ... F... 4C a... F... 4D.

F ... 1 3 ... T ... W ... N ... TAE, TEAE, ... SAE ... a ...


A
Left eye
Right eye
Left eye
Right eye
B
Left eye
Right eye
C
Same eye
**
TEAE
3.00
2.00
1.00
0.00
NonDiamond
Diamond
D
Different eye
**
TEAE
2.00
1.50
1.00
0.50
0.00
NonDiamond
Diamond
E
Effect of perceptual grouping
**
0.30
0.20
0.10
0.00
Same eye
Different eye

[illegible]

[illegible]

## Discussion

[illegible]

[illegible] [4 8] [illegible] [32]? [illegible] [33]. [illegible] MRI [illegible] (MEG) [illegible] [34 37]. [illegible] MRI [illegible] BOLD [illegible] LO [illegible] V1 [illegible] [14, 15]. [illegible] BOLD [illegible] [38], BOLD [illegible] [32]. [illegible] [39]. [illegible] V1. [illegible] [40]. [illegible]

Supplemental Information

[illegible] :10.1016/j. [illegible] b.2012.04.026.

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R [illegible] : F [illegible] 11, 2012
R [illegible] : Ma [illegible] 28, 2012
A [illegible] : A [illegible] 13, 2012
P [illegible] : Ma [illegible] 10, 2012

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