SYMPOSIUM

“EXPERIMENTAL METHODS IN PERCEPTUAL ORGANIZATION”

TEAP 2012, MANNHEIM
TUESDAY APRIL 3, ROOM 0 148, 9:00-11:00
Symposium overview

Convenors: Tandra Ghose & Johan Wagemans

- 09:00 Johan Wagemans (Leuven, Belgium): A century of Gestalt psychology in perceptual organization: A brief historical, conceptual and methodological introduction
- 09:20 Stephen E. Palmer (Berkeley, U.S.A.): From image structure to surface perception: Advances in understanding perceptual organization
- 09:40 Michael H. Herzog (Lausanne, Switzerland): The microstructure of motion correspondences revealed by the Ternus-Pikler display
- 10:00 Walter Gerbino (Trieste, Italy): What type of rectangle is a square?
- 10:20 Rob van Lier (Nijmegen, The Netherlands): Filling in vision
- 10:40 Mary A. Peterson (Arizona, U.S.A.): Figure-ground segregation as a dynamic interactive process
Johan Wagemans

A century of Gestalt psychology in perceptual organization: A brief historical, conceptual and methodological introduction

Laboratory of Experimental Psychology
University of Leuven
How Gestalt psychology started


- anecdote

- phi motion
  - [http://psych.purdue.edu/magniphi/](http://psych.purdue.edu/magniphi/)

- key role
  - phi as pure motion, not a displacement of a single object at two locations
  - phi as a process, “an across in itself”, that cannot be composed from more primitive percepts

Max Wertheimer (1880-1943)
Gestalt theory (Berlin school)

- not Gestalt qualities added to the primary sensations
- not Gestalts as *more* than the sum of the parts
- but Gestalts as *different* from the sum of the parts
- often the whole is grasped even before the individual parts enter consciousness
- a structured unit emerges as a whole
- continuous whole-processes rather than associated combinations of elementary excitations
implications of this view

- primary relations
  - no longer stimulus ~ sensation
  - but stimulus pattern ~ perceived whole
- perceived wholes
  - not constructed in the mind from elementary sensations
  - but direct experience-correlates emerging in the brain
Some early Gestalt history


decisive step

- real physical Gestalts in the brain
- psychophysical isomorphism
  - psychological facts and the brain events that underlie them are similar in all of their structural characteristics
  - in fact: the brain described as a self-organizing physical system

Wolfgang Köhler (1887-1967)

- development of **Gestalt epistemology** and outline of the research practice of **experimental phenomenology** that was based on it

- specifically:
  - the perceptual field does not appear to us as a collection of disjointed sensations, but possesses a particular organization of spontaneously combined and segregated objects
  - use descriptions of conscious experience in terms of the units people naturally perceive, rather than the artificial ones imposed by standard scientific methods
Some early Gestalt history


- an attempt to elucidate the fundamental principles of that organization
- the most general principle was the law of Prägnanz: the perceptual field and the objects within it will take on the simplest and most encompassing (“ausgezeichnet”) structure permitted by the given conditions
- Köhler: a tendency to achieve the maximal level of stability (homogeneity, simplicity, symmetry) with the minimum expenditure of energy allowed by the prevailing conditions
- specific principles:
  - proximity, similarity, uniform density, common fate, direction, good continuation
  - “whole properties” (or “Ganzeigenschaften”) such as closure, equilibrium, and symmetry
Open-ended research program

• Flourishing period:
  – Kurt Gottschaldt on embedded figures (1926)
  – Joseph Ternus on phenomenal identity (1926)
  – Karl Duncker on induced motion (1929)
  – Wolfgang Metzger on a homogeneous Ganzfeld (1930) and motion in depth (1934)

• Extensions beyond visual perception:
  – other modalities (e.g., hearing by Erich von Hornbostel)
  – learning and memory (e.g., Otto von Lauenstein and Hedwig von Restorff)
  – thought (e.g., Karl Duncker)
  – action and emotion (e.g., Kurt Lewin)
  – neuropathology (e.g., Adhemar Gelb and Kurt Goldstein)
  – film theory and aesthetics (e.g., Rudolf Arnheim)
Decline and fall

• External circumstances:
  – emigration to U.S.A.
  – early death of Koffka, Wertheimer, Duncker, Gelb, Lewin, etc.

• Intrinsic limitations of a methodological and conceptual nature:
  compared to the rigor of psychophysics and behaviorism, Gestalt psychology was severely criticized for:
  – offering mere demonstrations
  – using either very simple or confounded stimuli
  – formulating laws with little precision
  – adding new “laws” for every factor shown to have an influence on perceptual organization
Last 50 years

• despite these problems, Gestalt thinking did not disappear from the stage completely

• in the slipstream of Shannon’s information theory, a few researchers tried to provide a quantitative underpinning to the central Gestalt notion of simplicity (e.g., Attneave, 1954; Attneave & Arnoult, 1956; Hochberg & McAlister, 1953; Leeuwenberg, 1969, 1971; for a review, see Hatfield & Epstein, 1985)

• a number of independent, original scientists working on perception and information processing kept some Gestalt issues on the research agenda (e.g., Fred Attneave, Wendell Garner, Julian Hochberg, Irvin Rock)
Last 50 years

- these became more prominent again with the discovery of true Gestalt phenomena such as global precedence in hierarchical letters (e.g., Navon, 1977), configural superiority effects based on emergent features (e.g., Pomerantz et al., 1977), and the importance of hierarchical structure in perceptual representations (e.g., Palmer, 1977)

- the experimental paradigms were derived from standard methods in cognitive psychology, and the results were incorporated into mainstream information-processing accounts (e.g., Beck, 1982; Kubovy & Pomerantz, 1981)

- in the last two or three decades, perceptual grouping and figure-ground organization—the most central topics of Berlin school research—have returned to center stage (e.g., Kimchi et al., 2003), although the relationship to the original Gestalt theory is not always clear
## Problems in old-school Gestalt psychology and how they are solved in contemporary research

<table>
<thead>
<tr>
<th>Problems</th>
<th>Solutions</th>
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<tr>
<td>Laws formulated with little precision</td>
<td>Quantification, which allows measurement</td>
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<td>Proliferation of laws</td>
<td>Unification into stronger, better developed theoretical frameworks</td>
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<td>No mechanistic understanding</td>
<td>Computational models</td>
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<td>Poor understanding of neural basis</td>
<td>Somewhat better understanding of neural basis</td>
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Problems in old-school Gestalt psychology and how they are solved in contemporary research

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<th>Problems</th>
<th>Solutions</th>
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<tr>
<td>Mere demonstrations based on direct (subjective) reports</td>
<td>Real experiments</td>
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<tr>
<td></td>
<td>• also indirect methods (matching, priming, cueing) and performance measures (accuracy, reaction time)</td>
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<td>• also psychophysical techniques (thresholds in detection/discrimination tasks)</td>
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<td>• also neuropsychological studies with brain-damaged patients</td>
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<td>Either very simple or confounded stimuli</td>
<td>Carefully constructed stimuli, sometimes also richer stimuli</td>
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<td>• allowing research of everyday tasks</td>
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<td>• allowing research of ecological foundations</td>
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<td>Grouping principles and laws of perceptual organization studied in isolation</td>
<td>Also studying relationships with other processes, e.g.,</td>
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<td>• visual contour completion in relation to surface geometry and layout</td>
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<td>• figure-ground organization in relation to shape and depth perception</td>
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Example 1: Grouping by proximity


Quantifying perceptual grouping

attraction

\(|v|/|a|\)

distance

\(f(v)\)
R² = 96.5%
slope (s): -8.41±0.12

Logistic regression

Pure Distance Law
Example 2: Symmetry as a F-G cue

Stimuli

Example Stimuli:  

SYMMETRY  

ASYMMETRY

6 jitter levels, average orientation jitter per contour element:

15, 20, 25, 30, 35, 40 degrees
2AFC-task: which of two intervals contains a shape?

- Target shape: symmetrical or asymmetrical
- Non-Target shape: random orientation
- __: adaptive procedure to estimate 75% correct threshold
Results

The graph shows the proportion correct as a function of orientation jitter. Two curves are presented:

- Solid black circles represent the 'symmetry' condition.
- Open grey circles represent the 'asymmetry' condition.

The proportion correct decreases as the orientation jitter increases, with the 'symmetry' condition generally showing a higher proportion correct than the 'asymmetry' condition across all jitter levels.
Example 3: Interaction between contours and surfaces

How are **surface** and **contour** information **combined** in a shape detection task?
Experimental logic

1. adaptive procedure to ensure equal performance on contour and surface trials

2. collect data for
   a. contour (single cue)
   b. surface (single cue)
   c. surface & contour (combined cues)

3. calculate probability summation rule and ideal observer rule from performance on single cue trials

4. compare performance on combined cue trials with
   a. single cue performance
   b. probability summation rule
   c. ideal observer rule
Methods

• stimuli
  – 30 elements on contour
  – 30 elements on surface
  – 300 elements in background
• 2-AFC task in blocks of 50 trials
• calibration of single-cue detectability
  – Experiment 1 (N = 8)
    • surface 30, contour 26-34, 9 jitter levels
    • 100 trials per data point in main exp
  – Experiment 2 (N = 6)
    • surface 30, contour 30, jitter levels adjusted to get 85, 75, 65% thresholds
    • 500 trials per data point in main exp
Results
Three take-home messages

1. Gestalt psychology is not dead and buried but alive and kicking

2. All vision science should try to address Koffka’s question: “Why do things look the way they do?”

3. Progress is possible by combining different methods and approaches
THANK YOU

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