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# STRUCTURAL IMBALANCE AND AESTHETIC PREFERENCE IN DOMESTIC CHICKS

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## Abstract

In Arnheim's (1954/1974) theory of structural balance, an image is more aesthetically pleasing when it demonstrates balance between multiple internal sources of directed perceptual force. Areas of balance and preferred object positioning are assumed to be near/at centre, and along major structural axes (horizontal, vertical, and diagonals). We studied expediencies in visual processing of structural misalignment in week-old domestic chicks (*Gallus gallus*), using a conditioning procedure to reinforce chicks for pecking at either an "aligned" or "misaligned" image as their training stimulus. Subsequently, a generalization testing phase (using less axially dense stimuli) established whether the chicks would retain their group category, or revert to chance responding. Chicks trained on the misaligned stimuli were more likely to prefer the misaligned test stimuli, while the aligned group reverted to chance responding. Findings are discussed in terms of action-relevant dynamic information resulting from the instability of the preferred images.

In the perception of an frame-cinctured artistic scene, the importance allocated to an item within the frame is largely contingent on its location. According to Arnheim (1954/1974), the Gestalt approach to aesthetics can reduce grouping properties to one – simplicity. Visual system organization of stimulus information links the understanding of cortical and cellular processing of objective stimulus characteristics to a concomitant phenomenology associated with form processing. The seemingly antinomic approaches of subjectivist and objectivist attributions of aesthetic phenomena can be reconciled by considering visual perception as a process of representation via simplicity, which can be expedited by Prägnant form (Verstegen, 2005). When an object is influenced by the frame's structure, a small amount of displacement from the skeletal zones of balance will cause the percept to have the aspect of movement towards or away from the area of tension, or being resolved toward a simpler gestalt.

Arnheim's *experimentum crucis* of this phenomenon is given in Figure 1A. In the image, the black disc appears unsettled between balanced and imbalanced states.

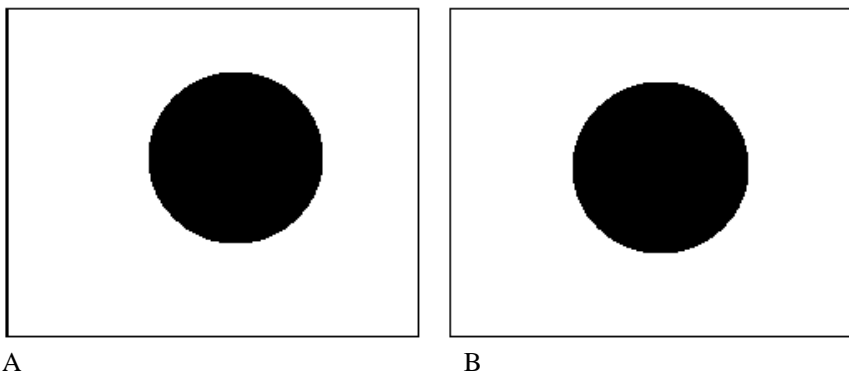


Fig. 1 from Arnheim (1974). An offset item (A) and a balanced, on-axis item (B).

Recently, researchers have confirmed that Vernier acuity test performance is improved by distractors that cohere as a good Gestalt in comparison with distractors with no clearly discernible geometric shape (Sayim, Westheimer, & Herzog, 2010). This implies that an embedded item or form can be modulated by its context more efficiently when that context has a basic structure, and that this phenomenon occurs early in the visual system.

In agreement with Arnheim, Palmer (1991) found that participants gave higher aesthetic ratings to a circular probe when it was presented along global axes of symmetry (similar to those in Fig 1B). However, it cannot be assumed a priori that structural balance sufficiently reports the internal dynamics of force within an artwork to affect aesthetic pleasure in this way. In other words, it could be the case that a certain amount of structural tension could elicit greater interest in the work, and possibly the dynamical process itself induce aesthetic interest. People sometimes prefer more complex stimuli, which by their nature should be less fluent to process (Reber et al., 1998). As such, a common view in aesthetics is that people prefer uniformity in variety, or simplicity in complexity, as in when something complex is presented in a simple way (e.g. Dickie, 1997).

We investigated the influence of structural coherence on preference behaviour in domestic chicks (*Gallus gallus domesticus*). Chicks have been shown to demonstrate visual preference assessments that closely resemble the kinds of preference judgements made by humans (e.g. Nicki and Rogers, 1975; Ghirlanda, Jansson, and Enquist, 2002; Clara, Regolin, and Vallortigara, 2007). perceptual phenomena including visual illusions that are perceived in the same way as humans (Clara, Regolin, Zanforlin, & Vallortigara, 2006), and perceptual-social capacities such as the ability to recognise con-specifics and adopting behaviours relevant to these relationships (Nicol, 2004; 2006) and the innate preference for certain very particular stimulus configurations, such as faces (Rosa Salva, Regolin, & Vallortigara, 2010). The implication of these studies is that the phenomena are not dependent on human cortical architecture, but instead on the dynamic structure of visual cognition processes. Our aim in the current study was to investigate the possibility that aesthetic appreciation of object structural cohesion is attributable to cognitive dynamics.

It is hypothesized that misalignment of an item along a frame's major axis of symmetry will predict more consistent and robust orienting behavior in chicks, which can be attributed to an early (and of course culture-independent) predisposition to attend to these types of stimuli. This result would imply that chicks are sensitive to the same balance/unbalance of forces claimed to determine aesthetic preferences in humans. In the experiments reported here young chicks were trained (for food reinforcement) to peck at one of two similar diagonal configurations of dots (inserted within a square frame), which differed only in the position of one of the dots (either aligned with the other dots on the diagonal axis of the frame or misaligned with respect to the rest of the dots and thus off-axis). Generalisation tests were then run to test chicks' responses to modified versions of the stimuli, in order to verify whether any difference in performance was present between chicks trained on the aligned or misaligned configuration as reinforced stimulus.

## Method

*Subjects and rearing conditions.* Subjects were male domestic chicks of the Hybro strain (N =12 and 8, in Exp. 1 and 2 respectively) (*Gallus gallus domesticus*) hatched from fertilized eggs obtained weekly from a local commercial hatchery (Agricola Berica, Montegalda (VI), Italy). Chicks were reared socially for the first five days. On the day 6, they were isolated and then, for the duration of the experiment, the birds were kept food-deprived to between 90 and 80% of their *ad libitum* feeding weight.

*Stimuli.* All stimuli were printed on a rectangular white paper base (9 x 6 cm). Each stimulus consisted in a configuration of grey dots ( $\emptyset$  4 mm) within a square black frame (3.2 X 3.2 cm). During the initial

shaping phase a stimulus representing a single central dot was used (Fig. 1A). During the discrimination training phase stimuli consisted in one aligned and one misaligned (one item offset from axis by  $\frac{1}{2}$  of its radius) configuration of 3 or 4 adjacent dots (in Exp. 1 and 2 respectively, Fig. 1B). In order to eliminate the possibility of cross-axial alignment, the item closest to the frame was distanced  $\frac{1}{8}$  of the frame's length (and height) from the bounding line. The upper left quadrant was selected due to its potential for enhanced relevance and augmentation of the effect of structural misalignment, because this location optimally exploits the effects of visual gravity as well as reading sequence (Arnheim, 1954/1974; Palmer, 1991). The main difference occurring between the two configurations was the position of the second dot from above, which in the misaligned configuration was off-axis. Finally, during the generalisation test phase, "spread apart" versions of the training stimuli, obtained by increasing the distance between the dots, were used (Fig. 1C).

*Apparatus and procedure.* The experimental apparatus (Fig. 2) consisted of a rectangular white-painted cage (33 x 38 x 60 cm) with a slit at the bottom of one of the short walls through which the food-box (6 x 6 x 12 cm) could be introduced. The food-box had a drawer that could be pushed open from outside of the cage by the experimenter in order to allow access to the food. The stimuli were fixed on the top of the food-box (at  $45^\circ$ ).

Shaping started in the morning of day 8, after chicks had been food-deprived overnight. Each chick was trained to peck at a stimulus, which was placed over the food box, in order to open the food-box drawer. In this phase the single dot stimulus was used (Fig. 1A). Shaping was considered complete after the chick had promptly pecked at the dot during 10 consecutive trials. From day 8 to approximately day 11 or 12, chicks underwent discrimination training. During this phase the chicks were presented with two identical boxes, each one associated with a different stimulus (one misaligned and one aligned configuration formed of 4 adjacent dots in Exp. 1 and of 3 dots in Exp. 2, see Fig. 1B). Half of the chicks were assigned to the aligned condition (G1) and half to the misaligned condition (G2). For G1-chicks, the misaligned configuration was the positive stimulus: only pecks to that configuration were reinforced by opening the food box (when the chick pecked at the other stimulus, it was quickly pushed back with a mobile partition and, after 15 s, it was released for the next trial). The opposite was true for G2-chicks.

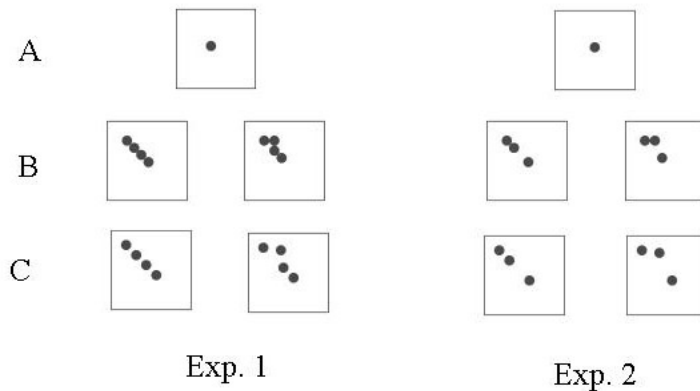


Fig. 2 Stimuli used for the shaping (A.), discrimination training (B.) and generalization testing phase (C.).

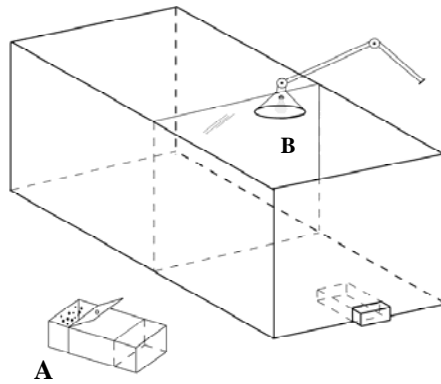


Fig. 3 Schematic representation of the apparatus. A. food-box; B. movable partition;

During this learning phase, the left-right position of the two stimuli changed from trial to trial according to a semi random sequence. At the beginning, in order to make it easier for the chicks to learn the discrimination, the positive stimulus was rendered more perceptually distinctive. In order to do so, one of the grey dots (the second dot from above, whose position differed between the aligned and the misaligned configuration) was substituted by an identical sized red dot. When the chick had achieved this facilitated discrimination according to a flexibly defined learning criterion, it was retrained with an identical pair of stimuli both composed of grey dots only. This discrimination-learning phase stopped when the chick had pecked at the correct stimulus in 17 of 20 consecutive trials (i.e. the learning criterion was reached). About 1h after the end of the training phase, chicks underwent a generalisation-test consisting in 20 consecutive trials during which pecks at either stimulus were reinforced (the left-right position of the stimuli was changed from trial to trial according to a semi random sequence). The number of correct choices made by each animal was scored. The main difference with respect to the training phase was that stimuli used in the test phase were “spread apart” versions of those used at training, Fig. 1C (this allowed us to test whether G1- and G2-chicks differed in their generalisation ability).

### Results

In both Exp. 1 and Exp 2. the number of correct responses performed by chicks (out of 20 trials) during the generalisation test was significantly higher in G2- than G1-chicks (Exp. 1,  $t_{10} = -3.702$ ,  $p = .004$ ; Exp. 2,  $t_6 = -2.673$ ,  $p = .037$ ). Moreover, in both experiments chicks' performance was higher than chance level (10 correct trials out of 20) in G2 (Exp. 1, mean = 14.17, SEM = .872,  $t_5 = 4.776$ ,  $p = .005$ ; Exp. 2, mean = 13.5, SEM = 1.041,  $t_3 = 3.363$ ,  $p = .044$ ), but not in G1 (Exp. 1, mean = 10.33, SEM = .558,  $t_5 = .598$ ,  $p = .576$ ; Exp. 2, mean = 8.5, SEM = 1.555,  $t_3 = -.965$ ,  $p = .406$ ).

We also considered the number of trials needed to reach the learning criterion during the training phase by the chicks of the G1 and G2 groups. This difference was not significant (Exp. 1,  $t_{10} = 1.011$ ,  $p = .336$ ; Exp. 2,  $t_3 = -2.257$ ,  $p = .101$ ). As chicks might have taken a similar amount of trials to achieve the learning criterion, while nonetheless having different numbers of trials correct, we analysed the groups for correct responses prior to criterion, and again found no significant differences (Exp. 1,  $t_{10} = 1.38$ ,  $p = .198$ ; Exp. 2,  $t_6 = -1.101$ ,  $p = .313$ )

Thus, in both experiments, chicks trained on the misaligned stimulus had a more adherent performance in the generalisation test than chicks trained on the aligned configuration. In fact, only the

performance of chicks trained on the misaligned stimulus was above chance at test.

## Discussion

That chicks in the misaligned group performed significantly above chance demonstrates that any chicks can potentially differentiate between the stimuli. The second experiment aimed to reduce the amount of items in the display configuration. In this way, the information present for direct training-testing stimulus matching is reduced, while the amount of axial noncoherence of the figure as a whole expanded stimulus is increased. In other words, the possibility of generalizing from the training to the testing stimulus is not affected, while the nature of the stimulus dynamics are more pronounced in the off-axis testing stimulus. The results of these two experiments imply that generalization of the category structural (mis-)alignment can be achieved by young domestic chicks, and that those chicks who were trained with a stimulus that cohered less with a structural axis were more likely to retain a preference for these types of stimuli in the absence of explicit reinforcement for that category (as was the case at test). Such a finding lends evidence for the proposition that some aesthetic structural preferences are a property of dynamic visual representation, and are not species- or culture-specific.

In other experimental studies, Palmer, Gardner, and Wickens (2008) investigated the optimal positioning and facing-direction of objects within a frame with regard to an aesthetically pleasing experience for a viewer. The authors follow Arnheim in stating that the perceptual centre (but not necessarily the geometric centre) has pre-eminence, and an object placed here will be regarded with highest importance. The authors found that centre-positioned objects were much preferred to the side positions with objects facing out of the frame, when those objects are traditionally associated with movement in a particular direction (people, vehicles). The objects positioned away from the centre were only preferred if they were centre-facing. This work suggests that the perceptual tension involved in grouping elements within the frame leads to a “pull” towards the centre, and that items that face way from centre oppose this, and their implied motion is at odds with the frame’s dynamics.

Freyd (1987) has argued that perception involves the acquisition of information about possible transitions in visual scenes. This is suggested to occur even in the absence of explicit dynamic information. In other words, static images may provide temporal information, or that representations themselves are inherently temporal. Freyd states that information about the images is subservient to information about their transitions. As such, when no temporal information is obtained, the visual system seeks out potential transitional states. The hypothesis is taken to refer to higher level perceptual organisation, similar to the Gestalt proposition that common dynamic information can group low-level perceptual primitives into a wholly perceived object (see e.g. Spelke, 1982, for empirical evidence of this from infant studies). Freyd observed that if photographs of an object “frozen” in the process of motion are presented to an observer, the participant (because they perceive the potential for motion, and create a representation that captures this motion) is shown to demonstrate a memory distortion whereby they will erroneously match an image further along in implied motion to the original stimulus.

Recently, researchers have suggested that the process of dynamically representing a visual scene can itself be a source of aesthetic pleasure, by lending a temporal dimension to an aesthetic work (van Zoest, Hunt, & Kingstone 2010). Specifically, and in line with Arnheim's theory and the work presented here, the process of representing a visual image is dynamic, and subjective appreciation of this experience can be enhanced by semantic elements in an artwork. The experience is nonetheless objectively attributed. Freyd argues that intrinsic temporal information may be non-imagistic, and may extend to propositional action-oriented concepts. Helmholtz (1894) suggested that all object perception involves knowledge of possible transitions or transformations. As such, an item may appear more interesting or salient when it implies action, even in the absence of dynamic information, or explicit demonstration of that action. Such an idea might account for the findings demonstrated here.

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