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How Can Experts See the Invisible? Reply to Bilalić and Gobet

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Abstract

Experts in all fields are able to see what is invisible to others. Experts are also able to see what is visible to all—and this is explored by Bilalić and Gobet. We question the method of normalizing all subjects in an experimental condition, and asking experts to behave as if they were novices. We claim that method leads Bilalić and Gobet to a *nonsequitur*.

Keywords: Decision-making; Perception; Representation; Problem-solving; Chunking; Abstract vision

In October 2008, Makoto Kobayashi, Toshihide Maskawa, and Yoichiro Nambu shared the Nobel Prize in Physics for discoveries concerning subtle aspects of broken symmetry. Suppose one were to hand these experts a set of 24 textbook-like physics problems and ask them to classify the problems based solely on surface similarity—that is, the same objects, like ''pendulum,'' or the same terms, like ''friction,'' or the same specific configuration of objects, such as ''blocks on an inclined plane.'' We safely assume that these three men would be able to tell apart problems in which there is a pendulum from problems lacking a pendulum. The task is trivial.

What is not trivial is how experts can see the invisible. When Chi, Feltovich, and Glaser conducted the aforementioned experiment, asking experts (Physics PhDs) and novices (1st year undergraduate students) to classify physics problems based on ''similarities of solution'' (Chi, Feltovich, & Glaser, 1981, p. 124), they realized that *novices* classified problems using the particular, the concrete, the superficial, the pendulums, the blocks on inclined planes, the problems with same words (e.g., ''center of mass'').

But experts behaved quite differently. Experts classified the problems based on the abstract ideas, the physical laws, the meaningful structures underlying their solutions.

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A problem with a pendulum could be classified as similar to a problem with a block on an inclined plane if the solution to both involved ''conservation of energy,'' or, perhaps, ''Newton's second law.'' Their paper became a classic of the *Cognitive Science* journal.

Linhares and Brum (2007) extended the experiment to chess. Experts classified problems such as those on Fig. 1 as similar, while novices were stuck at superficial details. Bilalić and Gobet (2009) attack Linhares and Brum (2007), claiming basically that:

1. They have reproduced the experiment, including a condition in which subjects were asked to match problems based on superficial similarities which support the POS theories of chess encoding (POS is their acronym for a ''pieces-on-squares'' encoding of a position; i.e., ''there is a white knight at A3'').
2. Expert subjects were successfully able to execute ''pairings using surface similarities.''
3. Therefore, ''experts simply do what they are told to do.''
4. Therefore, the task used in Linhares and Brum (2007) is ''inadequate for drawing any conclusions about the nature of expert's perception.''

We fully agree with (1), (2), and (3), and we are pleased to see the results reproduced. We would like to, however, discuss how (3) does not imply (4).

Let this much be clear: it is with immense respect that we criticize Bilalić and Gobet (2009), for some of the most influential ideas on our own work stemmed from the work of Gobet and colleagues. Some of their ideas which took much time and effort to form, for example, are that (a) perception lies at the core of chess cognition, (b) pattern-recognition tasks are much more important than ''looking ahead''; or (c), in the long run, only computational modeling can offer serious, nonambiguous, scientifically refutable theories of expertise. We may disagree with some details, such as POS encoding as *the key* representation, but not with their research programme.

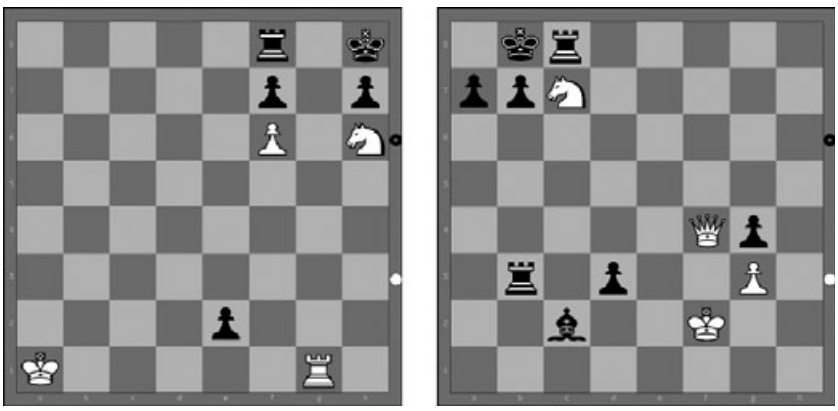

Fig. 1. Experts often smile analyzing these positions. The deep similarity between them is simply invisible to beginners (White to move; see Linhares & Brum, 2007 for solutions).

There is a basic asymmetry between experts and novices. Novices cannot behave as experts. But experts can behave as if they were novices. In our view, the flaw in reasoning stems from the fact that *novices* did not ''simply do what they were told to do.'' *Novices did not do much at all*. Novices did not match strategically similar scenarios, because they simply could not see them. And this leads to the contribution in Linhares and Brum (2007): Experts can match positions based on strategic similarity. Beginners cannot.

This difference is crucial, as it shows that experts have acquired the remarkable ability to encode positions at an abstract level, which includes analogies and the fluid perception of the abstract roles that pieces play—and this is diametrically opposed to the superficial encoding emphasized in POS theories.

Consider the difficulty involved in their new condition: In Fig. 1 of their paper, they show Linhares and Brum's positions 14, 15, 17, and 18. All a subject has to do is look at POS pairings to point out the superficially similar positions. More pieces in the same squares define the task, to succeed one must only be able to count and saccade eyes; not even the rules of chess are necessary. No emphasis is placed on the real issue: the asymmetry between experts and novices on strategic scenarios, and the wide-ranging implications to current POS theories.

Claim (3) is true—but not relevant to the cognitive abilities pointed out in Linhares and Brum (2007). Claim (3) would also be true in Chi et al. (1981) study, supposing one asked Physics PhDs to point out which problems have pendulums, as they would, of course, ''succeed.'' Should we then establish that Chi et al. (1981) is also ''inadequate for drawing any conclusion about the nature of expert's perception''? We think that would be an inappropriate conclusion.

Progress in understanding expertise, meaning, intentionality, abstract vision, and deep perception will probably not come from asking Physics PhDs to find pendulums; or from asking chess masters to count the number of pieces occupying the exact same squares in different boards. A group of experts can always behave like a group of novices—but the opposite is not true. The *asymmetry* between groups is what points to experts' abilities to see the invisible.

We maintain that the task posed by Linhares and Brum (2007) sheds new light on the asymmetry between chess experts and novices—and that those results demand more than POS theories of encoding. In Fig. 1, there is enormous strategic similarity with zero piece-on-square matchings. We claim, moreover, that, by asking experts to conduct tasks in which novices succeed, this experimental condition normalizes all people and diverts attention from the interesting phenomena. Bilalić and Gobet's attack on our task as ''inadequate for drawing any conclusions about the nature of expert's perception'' is, we claim, *ignoratio elenchi.*

With this, we invite interested readers, the final judges in this debate, to re-read Bilalić and Gobet's attack and arrive at their own conclusions.

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