# Representationalism Defended: Comments on Egan, “How To Think About Mental Content”

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Frankie Egan distinguishes between mathematical content and cognitive content. She thinks that theories of mental content should confine themselves to the former. Cognitive content is a “gloss” that “serves a heuristic purpose and is subject to a host of pragmatic considerations.” Frankie’s distinction between two kinds of content is an important contribution, but I disagree with her assessment of cognitive content. Mathematical content is overlooked; however, the relationship between mathematical and cognitive content shows how properly to understand the relationship between the perceiving subject and her environment.

1. Mathematical Content

Consider an on-centre, off-surround retinal ganglion cell. Such a cell:

(a) is *excited*, i.e., fires faster, when the centre of its receptive field is in bright light, or when the surround of this centre is in darkness,

(b) is *inhibited* when the centre is in darkness or the surround is in light, and

(c) is *at base rate* in intermediate conditions.

Consequently, if the whole receptive field is in light or in darkness, the excitation of one part cancels the other, and the cell fires at base rate. But if the centre is in bright light and the surround in darkness, the cell is maximally excited. And finally, if the surround is in bright light and the centre is dark, the cell is maximally inhibited.

Now imagine a luminance edge, bright to the right, dark to the left. Here is a sequence of positions such an edge passes over this cell:

[Figure 1 here]

At the beginning of the sequence, the whole cell is in the light; thus the centre responds positively and the surround negatively. Thus, the cell fires at base rate. In between the edge starts to pass over the surround, so that some of the surround is in darkness, but the centre and the rest of the surround is in the light. This causes the cell to be inhibited relative to base rate. After a while, the centre and most (but not all) of the surround is in the dark. This causes the cell to be inhibited relative to base rate.

Cumulatively, the cell is a function from the position of the edge to firing rate. Counting only the maxima in each direction, the cell is an edge detector, firing above base rate when there is a brightness-right edge to the left of the centre, and below base rate when such an edge is to the right of the centre. Marr assumed that an assemblage of such cell would detect luminance edges *in the world—*not just in the cell itself—but Frankie suggests that if light behaved somewhat differently, it would detect something different. Along similar lines, if there was a refraction boundary, the edge might be misrepresented. It is certain that the cell computes a certain function from a luminance distribution to {-1, 0, 1}, but not certain what in the outside world this function will “detect” or represent.

1. Naturalizing Mathematical Content

Frankie writes:

It is not likely that this content [viz. “mathematical contents”] could be *naturalized,* as Hyper Representationalism requires. What robust relation, specifiable in non-semantic and non-intentional terms, holds between the structures that make up the gray-level array and (just) the mathematical objects to which they are mapped in the interpretation? Indeed, it is hard to see what naturalization would amount to here. At very least, the naturalistic proposals currently on offer – information-theoretic accounts that depend on a causal relation, teleological accounts that advert to evolutionary function – are non-starters.

I am not at all clear what the problem is. Let G be a variable ranging over grey-level arrays, and for each G, let CG range over on-centre/off surround receptive fields in G. Then we can define a function R from CG to {-1, 0, -1} as follows:

R = 1 if G contains a brightness-right illumination edge immediately to the left of the centre of CG *&* R = -1 if G contains such an edge immediately to the right of the centre of CG *&* R = 0 otherwise.

The function R is specified in non-semantic terms, i.e. in terms of extensional conditions that hold of grey level images. Further, one can experimentally verify that cells have such properties, or at least one can verify that the output of the cell is three valued and that one of each of these values is uniquely assigned to the conditions mentioned.

Perhaps what Frankie means is simply that the naturalistic methods usually used to specify representational relations to the external world are useless when we are specifying content. This is contentious. Take the teleosemantic analysis, for example. Could it be said that centre-on/surround-off cells are selected because they compute the function R? Or that these cells carry information about R? I don’t see why not. Of course, these statements are explanatorily incomplete. But Frankie says they are “non-starters.” I can’t see why. They can’t finish the race on their own, as we’ll see in a moment. But it seems to me that they are starters.

There is a problem that is traditionally posed with regard to functions such as R, namely *how* the cell computes it. The traditional answer, at least since Cummins (1975), is: Functional analysis tells us how. In the preceding section, I gave one level of the functional analysis: the addition of excitation and inhibition levels and the specification of the conditions under which the cell is excited or inhibited. Several more levels are needed: we need to know how excitation and inhibition levels are added, how the conditions specified lead to excitation and inhibition, and so on. Presumably, cell chemistry tells us this. Functional analysis seems to be the required naturalization of the cell computing R, and of mathematical content generally.

There is, of course, a different problem that functional analysis does not address. (I nearly wrote “deeper” for “different,” but actually I think the problem is finicky rather than deep.) The question, posed for instance by Baker and Hacker, is this: What does it *mean* to say that a cell computes a function? Doesn’t this falsely attribute intelligence and agency to something that does not possess these things? I am not going to say anything about this problem, and I think Frankie doesn’t want to either. Functional analysis is an answer to the how question. It is not an answer to the what-does-it-mean question.

1. The Problem of Error and the Cognitive Interpretation

I said earlier that Marr assumed that edge detectors detected *edges*. Edges are, I believe, abrupt changes in illumination in the scene being viewed. Frankie remarks:

Given their role in explanation, candidates for content must be *salient* or *tractable.* The structure *EDGE* in Marr’s theory represents a change in depth, surface orientation, illumination, or reflectance, but if the causes of a structure’s tokening are too disjunctive the theorist may decide to assign a proximal content to the structure (for example, zero-crossings represent discontinuities in the image)

I do not think that Marr saw it this way. He did not assign proximal content to edges. In the early stages of visual processing, edges are, for him, just whatever out there causes sharp changes of luminance. That’s unified enough for (very) early vision. The more specific causes of luminance-discontinuities—object boundaries, changes in orientation, etc.—are left to be determined later in visual processing.

However this might be, Frankie’s distinction is both correct and important. To say that edge detectors compute “the Laplacean convolved with the Gaussian” is to attribute mathematical content to them; to say that on-centre cells compute R (above), which (as I understand it) approximates “the Laplacean convolved with the Gaussian” is a first move toward functional analysis. However, to say that edge detectors represent external world edges is quite different from either. Edges are *cognitive content*. Frankie calls them a cognitive *interpretation* of R.

Now, functional analysis cannot be used to analyse cognitive content. The problem is this. R is a representation of what an edge detector is doing. But, as Frankie emphasizes, not every non-zero value of R (i.e., -1 or +1) corresponds to an edge. In worlds, where the conditions are very different, edges might be shadows. (It’s not quite relevant, but don’t shadows have edges in our world?) And, of course, the content produced later vision can be mistaken even in our world. The figure below looks like a photograph of a sphere, but it can be a cleverly produced lighting effect:



Since the visual system does not distinguish between the two, the functional analysis of its activity in producing a representation of a sphere will equally well apply to what it does with a cleverly lit facsimile. The same representation is produced in both cases. If a lighting trick is represented as a sphere, it is erroneously so represented. This is the Problem of Error, and it defeats functional analyses of representing spheres. More generally, it is a problem for functional analysis as applied to cognitive content.

The problem of error becomes acute when the information available to the eye underdetermines the kind of thing that is seen. Assuming that the retina is impressed by a two dimensional image, the kind *sphere* is underdetermined in this way. On this assumption, every representation of the kind *sphere* is subject to error. (Of course, the assumption is overly simple: we do have two retinas, and we are able to move around and thus receive information from a number of different angles.)

The problem of error is appropriately addressed by a Response-Dependency theory. Let C be the mathematical content produced by vision in the case of the sphere, above. Suppose that adult humans typically react to C-objects as if they were spheres. For example, in reaching out to lift C-objects, humans cup their hands; if they see such an object on a slope, they expect it to roll, and so on. Response Dependency theories would say that these responses show that C-content is treated as Sphere-content. Now suppose that there is evidence that these responses are innate. For instance, we might find “canalization” of development. It is found that children converge on the responses even without much exposure to spheres, given very different ecologies—Arctic, prairie, rain-forest—in which naturally occurring spheres both look different and act different. Then we might conclude that humans innately respond to C-objects as if they were spheres. This would be what Frankie calls an intentional gloss, though the gloss would be based on something innate in the visual system, rather than on some extrinsic commentary.

Frankie allows that:

. . . since the theory must explain the organism’s manifest success at computing the cognitive function in its normal environment (e.g. seeing what is where, grasping objects in view), it must also advert to general facts about that environment that explain why computing the mathematical function specified by the theory, in context, suffices for the exercise of the cognitive capacity.

Thus the theory will include two components, she says: first, how it computes C and second,

environment-specific facts as that a co-incidence of sharp intensity gradients at different scales is likely to be physically significant, corresponding to object boundaries or reflectance or illumination changes in the world.

But:

Cognitive contents . . . are *not* part of the essential characterization of the device, and are not fruitfully regarded as part of the computational theory proper. They . . . form what I call an *intentional gloss,* a gloss that shows, in a perspicuous way, how the computational/mathematical theory manages to explain the intentionally-described explanandum with which we began and which it is the job of the theory to explain.

This is where I disagree. First of all, talking about the “computational theory proper” is making an artificial distinction. Cognitive scientists are interested in ecological perception. They need not *simply* be content to say that an organism computes C, and succeeds because Cs are often spheres. They may want to say that organisms compute C, and has a tendency to take Cs as spheres *because* they are often so.

I’ll elaborate on this position in the next section.

1. Four Observations about Cognitive Content

#### Matching Content and Response The first thing to observe is that perceptual content might be taken to be explanatory with respect to response. Responses are of two sorts. First, there are motor responses. Earlier, I mentioned cupping one’s hands when one reaches to pick up a sphere. Second, there are epistemic responses. One has learned, let us say, that spheres roll down hills. (One does not believe that C-objects, or things that look like spheres, roll down hills. One has non-visual ways of distinguishing spheres from things that merely look like them.) Now, when on sees a C-thing on a slope, one expects it will roll. This expectation is a learned epistemic response to what one (innately) sees. Since one is able to distinguish non-visually between spheres and non-spheres, this expectation is explained by the fact that one took the C-object to be a sphere. Assuming that the link between C and sphericity is developmentally, not experientially, learned, i.e. that it is innately represented, it seems reasonable to say that cognitive content is psychologically significant. We don’t cite the C/sphere correlation simply as an extrinsic fact to explain the success of the cognitive capacity, or the fact that it is physically significant. We cite it also to explain the deployment of the cognitive capacity.

#### How Things Seem The general argument of the preceding subsection comports quite well with how things seem to us. Consider colour. Certain things look blue. This is not merely a matter of their looking as if they are blue (the epistemic sense of ‘look’), or looking similar to blue things (the comparative sense). There is a characteristic blue look, and when I say “That looks blue” in the phenomenal sense, I am saying that it presents this look. Something looking blue in the phenomenal sense is not the same as its looking as if it is blue, or looking similar to blue things.

 Many of one’s responses to things are based on how they look phenomenally. This provides an explanatory link between the Matching Content argument of the preceding subsection and visual phenomenology. We treat C-things as spheres because computing C is our way of visually identifying spheres. When this computation results in a conscious representation, things have the *phenomenal look* of a sphere, and we thus possess a conscious reason for treating them so.

#### Proximate vs Ultimate Explanation Ernst Mayr made an important distinction between two explanatory projects, which were, according to him, sometimes conflated. The first has to do with how a structure is biologically produced. This is what he called proximate explanation. The second has to do with the evolutionary reason for the structure. This, he called ultimate explanation.

Kevin Lalande et. al. (2011) explain the distinction through the example of bird migration:

The example that Mayr used to illustrate this distinction, avian migration, drew on his early career as a naturalist. Mayr emphasized that, to fully comprehend migration, we need to understand both why birds migrate (its selective advantage) and how they migrate (how they time migration, how they navigate, etc.).

Mayr was acutely aware of the fact that proximate and ultimate accounts of bird migration had been wrongly juxtaposed as alternatives and stressed that “many heated arguments about the ‘cause’ of a certain biological phenomenon could have been avoided if the two opponents had realized that one of them was concerned with proximate and the other with ultimate causes”

Lalande et al argue that this distinction can become complicated when cultural evolution and learning enter the picture. However, I have been assuming that these factors do *not* operate in at least some domains of perceptual content. Where this simplifying assumption holds, the authors remark, correctly, that:

Mayr’s concern that proximate and ultimate explanations should not be regarded as alternatives remains entirely valid today and is an important and useful heuristic that applies broadly across biological disciplines. There will always be how and why questions, and their answers will always be complementary rather than conflicting.

Arguably, the relationship between mathematical and cognitive content is of this sort. The functional analysis of how we compute C is how we visually identify spheres, the evolutionary usefulness of detecting spheres is why we use C.

#### Special Sciences vs Physics Frankie downplays the “intentional gloss” in the following words:

Perhaps it *is* rather parochial of us to want to see the processes described in non-intentional terms in the theory as constituting the exercise of a capacity or competence, in other words, as *rational.* Nonetheless, *pace* Chomsky, there is no reason why science should not aim to explain the features of our experience that interest us, even if it tells us that *these features do not go very deep*. (Emphasis mine)

In a footnote, she adds:

It is not only the cognitive sciences that are grounded in the desire to understand ourselves and our place in the universe – the biological sciences are grounded in such interests as well. From the detached perspective of fundamental physics, the difference between life and non- living matter is no less arbitrary than the difference between a rational process and a mistake.

I am not very sure what one should take from these words. We are talking here about the subject matter of cognitive science. The physics viewpoint on the subject matter of this special science is surely irrelevant.

1. Conclusion: Pondering Chomsky

I’ll conclude these comments by expressing some puzzlement about something that Frankie quotes Chomsky as saying:

The representations are postulated mental entities, to be understood in the manner of a mental image of a rotating cube, whether the consequence of tachistoscopic presentations or of a real rotating cube or of stimulation of the retina in some other way, or imagined, for that matter. Accessed by performance systems, the internal representations of language enter into interpretation, thought, and action, but there is no reason to seek any other relation to the world...

Now it is obviously true that a mental image of a real rotating cube is not a relation between a thinker and a cube. There may well be no “real rotating cube” to which the thinker to be related. Thus it seems clear that what is at stake here is an imagistic mode of presentation—my mental image of the cube is an image that presents a cube as it would be seen, much as my thought about seventeen cubed is a representation of a number under a description, this time non-visual. But Chomsky goes on to say: “The theory itself has no place for the [intentional] concepts that enter into the informal presentation, intended for general motivation.” This makes it very difficult to understand what he takes a mental image of a rotating cube to be.

Now consider the position that Frankie counterposes against Chomsky’s, Hyper Relationalism, as she calls it. The core of this theory could be put as follows: a perceptual state is (a) essentially individuated by an ordered pair of a thinker and mode of presentation, and (b) is sometimes based on information that underdetermines what is presented. It seems to me that Hyper Relationalism is correct.