Determination in Yablo:
Distinction between the Mental/Physical in the Same Category

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Introduction

No one would deny that the mental and the physical are closely related. Although identity might be sufficient for this closeness, it is far from clear that identity is adequate or required for their intimacy. Is there any relation adequate enough to secure this closeness without identity? According to Yablo (1992b), one candidate will be *determination*: for *x* to be physical is for it to be mental in a specific way (physical events (properties) determine mental events (properties)). This seems to imply that (i) the mental and the physical are in the same ontological category, (ii) the mental as a determinable is distinct from its physical determinates. However, exactly what is the distinction between the mental and the physical in the same ontological category? The main purpose of this paper is to examine Yablo's idea in order to answer this question. In what follows, first, I will take a close look at Yablo's theory of essence based on which he claims that one candidate will be determination (Sec.1). Second, I will examine the implications of his theory of essence for relations between mental/physical events (Sec. 2). Third, I will discuss Funkhouser's theory of determination to give a detailed explanation of the determination of properties (Sec 3). Finally, I will examine what Yablo's idea implies for relations between mental and physical properties (Sec. 4).

1. Yablo's Theory of Essence

Yablo claims that at least two conditions should be considered in order to construct a theory of essence: an essence is 'in virtue of which' something is that thing, and it is 'what is required' for something to be that thing (1.1). His theory of essence is designed to satisfy these conditions and has some characteristic consequences (1.2-4).

1.1 Cumulative and Restrictive Properties

α's essence is thought to be a set of essential properties it has. However, what essential properties should be included is not obvious. According to Yablo, the following conditions should be taken in account to form a theory of essence (Yablo, 1987, pp. 297-8): (a) the essence of α should be such that a thing is α in virtue of its essence. For example, the essence of Socrates should be such that a man is Socrates in virtue of the properties in its essence like *being human* and *being a person*; (b) the essence of α should be a measure of what is required for it to be α. Therefore, if the requirement for β is stricter than for α, the essence of β is 'bigger' than that of α. For example, in order for an event β to be the speeding home, the event needs to satisfy more requirements than those for another event α to be the driving home. Therefore, intuitively the essence of β includes the essence of α and more essential properties.

In order to satisfy these conditions, Yablo offers the following distinction between cumulative and restrictive properties (ibid., p. 299):

> A property P is cumulative iff P does not exclude other properties (apart from in a trivial way) when included in an essence.
>
> A property P is restrictive iff P blocks the entry of other properties in the essences to which it belongs.

Typical restrictive properties are identity- and kind-properties.(1) For example, if we include *being identical with* α in α's essence, (a) is trivialized or becomes insubstantial. Also, α's essence with *being identical with* α rules out (b). It is impossible for β to have the property *being identical with* α because the essence of β includes the essence of α and *more* essential properties. Thus, according to Yablo, the essence of α includes only essential and *cumulative* properties. Then, the question is how to form an adequate theory of essence in this sense.

1.2 Attribute and Property

In order to think of α's essence, the following symbols are introduced: $\mathcal{L}$ is an ordinary first-order language with '=', $\mathcal{L}(\Box)$ is $\mathcal{L}$ with the sentential necessary operator '$\Box$'. A model of $\mathcal{L}(\Box)$ is a (non empty) set $\mathcal{W}$ of models W of $\mathcal{L}$: $\mathcal{W}$ is thought of as a set of possible worlds. In what follows, the domain of discourse and the ontological domain are distinguished. Each $W_1, W_2, ..., W_n$ of $\mathcal{W}$ has the same domain of discourse $\mathcal{D}$, but $W_1, W_2, ..., W_n$ has its own ontological domain $\mathcal{D}(W_1)$, $\mathcal{D}(W_2)$, ..., $\mathcal{D}(W_n)$ respectively. $\mathcal{D}$ is the union of $\mathcal{D}(W_1)$, $\mathcal{D}(W_2)$, ..., $\mathcal{D}(W_n)$, namely $\bigcup_{i\in A} W_i (A = \{1, 2, ..., n\})$ (for simplicity, suppose that n is finite here), and so each $\mathcal{D}(W_i)$ is a subset of $\mathcal{D}$.(2)

According to Yablo, an attribute P is a function from W to a subset of $\mathcal{D}$ (ibid., p. 301):

$$P: \mathcal{W} \longrightarrow \mathfrak{P}(\mathcal{D}) \ \ (W \longmapsto \{\alpha \in \mathcal{D} \mid \alpha \in P(W)\})$$

He distinguishes two kinds of attribute based on the conditions for something to have an attribute essentially. The first one is this:

> x has an attribute P of the first kind necessarily if it has it in every world.

This kind is limited to only *existence* and similar characteristics. In fact, in order for Socrates to have *existence* in every world, it is not sufficient for him to have it in every world where he exists; he should have it in every world. This allows the intuition that *existence* is sometimes accidental. The second one is called *property* and the characterization is this:

> x has an attribute P of the second kind necessarily if x has P in every world where it exists: $\forall x \in \mathcal{D}\ \forall W \in \mathcal{W}[(x \in \mathcal{D}(W) \longrightarrow x \in P(W)) \longrightarrow \forall W' \in \mathcal{W}(x \in P(W'))]$.

That is, if x has P in every world where it exists, then x has P in every world. Most characteristics are of this kind, and for example *being human* is a property: if Socrates is human in every world where he exists, then he is human in every world. This saves the intuition that *being human* is necessary for Socrates if he cannot exist without it. In the following, what is discussed is the second kind, namely an attribute as a property.

1.3 Essence and Refinement

Based on this conception of property, Yablo treats an essence as a set of essential and cumulative properties, and offers the relation of ‘refinement’ between essences (ibid., pp. 301-2). P’s ‘essentialization’, ‘possibilization’, and ‘accidentalization’ are introduced:

$$P^{\Box}: \mathcal{W} \longrightarrow \mathfrak{P}(\mathcal{D}) \quad (W \longmapsto \{\alpha \in \mathcal{D} \mid \forall W'[\alpha \in P(W')]\} \qquad \text{(P's essentialization)}$$

$$P^{\Diamond}: \mathcal{W} \longrightarrow \mathfrak{P}(\mathcal{D}) \quad (W \longmapsto \{\alpha \in \mathcal{D} \mid \exists W'[\alpha \in P(W')]\} \qquad \text{(P's possibilization)}$$

$$P^{\triangle}: \mathcal{W} \longrightarrow \mathfrak{P}(\mathcal{D}) \quad (W \longmapsto \{\alpha \in P(W) \mid \exists W'[\alpha \notin P(W')]\} \quad \text{(P's accidentalization)}$$

That is, P’s essentialization (possibilization, accidentalization) is this: for each P, it assigns $P^{\Box}$ ($P^{\Diamond}$, $P^{\triangle}$) that is a function from W to a subset of $\mathcal{D}$. In the case of $P^{\Box}$ and $P^{\Diamond}$, for every W they assign the same subset of D. By contrast, in the case of $P^{\triangle}$, for each W it may assign a different subset of D.

To see this, let’s think of the following model M_1:

$$\mathcal{W} = \{W_1, W_2, W_3\},\ \mathcal{D} = \{\alpha, \beta, \gamma\}$$

$$\mathcal{D}(W_1) = \{\alpha,\beta\},\quad \mathcal{D}(W_2) = \{\alpha,\beta\},\quad \mathcal{D}(W_3) = \{\alpha,\gamma\}$$

$$P(W_1) = \{\alpha,\beta,\gamma\},\ P(W_2) = \{\alpha,\beta,\gamma\},\ P(W_3) = \{\alpha,\beta,\gamma\}$$

$$Q(W_1) = \{\alpha,\beta\},\quad Q(W_2) = \{\alpha,\beta\},\quad Q(W_3) = \{\beta\}$$

$$R(W_1) = \{\gamma\},\qquad R(W_2) = \{\gamma\},\qquad R(W_3) = \{\alpha,\gamma\}$$

Since α,β have P in every world where α,β exist, α,β have P in every world. Therefore, α,β have P essentially (for example, $\alpha,\beta \in P^{\Box}(W_1)$). In the same vein, we can say $\beta \in Q^{\Box}(W_1)$. By contrast, $\alpha \in \mathcal{D}(W_1) \wedge \alpha \in Q(W_1)$ and $\alpha \in \mathcal{D}(W_2) \wedge \alpha \in Q(W_2)$, but $\alpha \in \mathcal{D}(W_3) \wedge \alpha \notin Q(W_3)$. Therefore $\alpha \in Q^{\Diamond}(W_1)$ and $\alpha \in Q^{\triangle}(W_1)$. Also, γ has R in every world where γ exists (γ

exists only in W_3 and $\gamma \in R(W_3)$), so γ has R in every world. Therefore, $\gamma \in R^{\Box}(W_3)$. Also, $\alpha \notin R(W_1)$ and $\alpha \in R(W_3)$, so $\alpha \in R^{\triangle}(W_3)$. In this way, what modal properties α, β, γ has in a world are determined on the basis of how they behave there and in other worlds.

The essentialization (accidentalization) of a set of properties is characterized as follows (hereafter, X is a set of properties):

$X^{\Box}(X^{\triangle})$: $X^{\Box}(X^{\triangle})$ is the essentialization (accidentalization) of X iff each element of X is essentialized (accidentalized).

Based on these, α's essence and refinement are defined below:

$\mathbb{E}_X(\alpha)$: α's X-essence, $\mathbb{E}_X(\alpha) = \{P \in X \mid \exists W(\alpha \in P^{\Box}(W))\}$.

Refinement: β is α's X-refinement (β refines α) iff $\mathbb{E}_X(\alpha) \subseteq \mathbb{E}_X(\beta)$.

That is, α's X-essence is the set of the properties in X α has essentially, and β is α's X-refinement if and only if α's X-essence is a subset of β's X-essence. In M_1, let X be $\{P, Q, R\}$. Then, $\mathbb{E}_X(\alpha) = \{P\}$ and $\mathbb{E}_X(\beta) = \{P, Q\}$, so $\mathbb{E}_X(\alpha) \subseteq \mathbb{E}_X(\beta)$. Therefore, β is α's X-refinement. In the same vein, $\mathbb{E}_X(\gamma) = \{P, R\}$, so $\mathbb{E}_X(\alpha) \subseteq \mathbb{E}_X(\gamma)$. Therefore, γ is also α's X-refinement.

1.4 Closed Property Model Ω

The last thing we have to do is to impose conditions on essences to make them sets of essential and *cumulative* properties (α^+: α's X-refinement)(Yablo, 1992a,b, p. 409, p. 234):

(κ) $\forall \alpha \in \mathcal{D} \forall W \in \mathcal{W} \forall P \in X$($\alpha$ exists and has P at W iff α^+ exists and has P essentially at W): $\forall \alpha \in \mathcal{D} \forall W \in \mathcal{W} \forall P \in X[\alpha \in \mathcal{D}(W) \wedge \alpha \in P(W) \leftrightarrow \exists \alpha^+ \in \mathcal{D}(\alpha^+ \in P^{\Box}(W))]$.

This condition rules out identity properties and kind properties of X. Suppose α exists at W and has a (cumulative) property P. If *being identical with* α is in X, by (κ) there is α^+ at W which has P and the identity property essentially. However, since α^+ has P essentially, it cannot be identical with α which has P accidentally. Therefore, identity properties violate (κ) and is ruled out of X. Next, suppose α is Brutus's stabbing Caesar and exists at W and has two properties *stabbing* (*St*) essentially and *killing* (K) accidentally. If a kind property *being the kind of stabbing* is in X, then by (κ) there is α^+ at W which has *St*, K and the kind property essentially. However, α^+ cannot have K and the kind property essentially at the same time because if it were true, all the stabbing events would be killing events. Therefore, kind properties violate (κ) and are ruled out of X. In this way, X is regarded as a set of cumulative properties.

When $\mathcal{W}$ is a model of $\mathcal{L}(\Box)$, then the set of $\mathcal{W}$ and X, $\Omega = \langle \mathcal{W}, X \rangle$, is called *a property model* of $\mathcal{L}(\Box)$. And if a property model of $\mathcal{L}(\Box)$ satisfies (κ), the property model is called *closed*. If a property model is closed, it follows that (Yablo, 1987, p. 303): ($\mathbb{W}$ is defined as $\mathbb{W} : \mathcal{D} \longrightarrow \mathfrak{P}(\mathcal{W}) \quad (\alpha \mapsto \{W \in \mathcal{W} \mid \alpha \in \mathcal{D}(W)\})$)

(1) $\mathbb{W}(\alpha^+) \subseteq \mathbb{W}(\alpha)$: $\forall W[\alpha^+ \in \mathcal{D}(W) \longrightarrow \alpha \in \mathcal{D}(W)]$: if α^+ exists at W, then α exists at W.

(2) $\forall W \in \mathbb{W}(\alpha^+)[\alpha \in (\mathbb{E}_X(\alpha^+) - \mathbb{E}_X(\alpha))^{\triangle}(W)]$: In every world where α^+ exists, α has all the properties in $\mathbb{E}_X(\alpha^+) - \mathbb{E}_X(\alpha)$ accidentally.

(3) $\forall W \in \mathbb{W}(\alpha) - \mathbb{W}(\alpha^+)[\alpha \notin (\mathbb{E}_X(\alpha^+) - \mathbb{E}_X(\alpha))^{\triangle}(W))]$: In every world where α exists but α^+ does not, it is not the case that α has all the properties in $\mathbb{E}_X(\alpha^+) - \mathbb{E}_X(\alpha)$.

Since M_1 ($\langle \mathcal{W}=\{W_1, W_2, W_3\}, X=\{P, Q, R\} \rangle$) is closed, let's see whether (1), (2) and (3) follow or not. α's refinement β exists at W_1 and W_2, and α also exists at W_1 and W_2. α's refinement γ exists at W_3, and α also exists at W_3. Therefore, we get (1). $\mathbb{E}_X(\beta) - \mathbb{E}_X(\alpha)$ is $\{Q\}$, and, as we saw in 1.3, $\alpha \in Q^{\triangle}(W_1)$ and $\alpha \in Q^{\triangle}(W_2)$. Also, $\mathbb{E}_X(\gamma) - \mathbb{E}_X(\alpha)$ is $\{R\}$, and $\alpha \in R^{\triangle}(W_3)$. Therefore, we get (2). β does not exist but α exists at W_3 and $\alpha \notin Q(W_3)$. Also, γ does not exist but α exists at W_1 and W_2 and $\alpha \notin R(W_1)$ and $\alpha \notin R(W_2)$. Thus, we get (3).

The important point is this: if β exists at W then α also exists there, but this is compatible with worlds W' where α exists and β does not exist. Suppose the following two situations: (i) Mary drove home speedily at W. Then, there are α and its refinement β at W such that β essentially has two properties *driving home* and *being speedy*, while α essentially has the former but accidentally has the latter;(ii) Mary drove home slowly at W'. Then, there are α and its refinement γ at W' such that α has *driving home* essentially and *being slow* accidentally, and γ essentially has both. (i) and (ii) are compatible, while in the worlds where α and γ exist but β does not exist, α has different properties accidentally unlike at W.

2. Refinement and Determination of Events

According to Yablo, determination is just refinement. One important thing about events in the determination relation is that they are contingent (2.1). Refinement and contingency are the keys to understand what relations hold for mental/physical events in his theory (2.2).

2.1 Refinement, Determination and Contingency

Yablo defines determination as follows (Yablo, 1992a,b, p. 431, p. 233):

> β determines α iff for β to exist at W is for α to exist at W, not *simpliciter*, but in a specific way.

As we saw above, if β is α's refinement, then for β to exist at W is for α to exist at W, not *simpliciter*, but in a specific way: β essentially has the properties α has accidentally.

Therefore, according to him it follows that β determines α iff β refines α. Thus, (1)-(3) also hold for α and β as a determinable and its determinate (Yablo, 1992b, p. 236).

One important point of refinement (determination) is that if β refines (determines) α, then they are *contingent*. In order to explain contingency, we need to look at the distinction between categorical and hypothetical properties (Yablo, 1987, p. 305):

> A property P x has at W is categorical if whether x has P or not strictly depends on only the way x is at W.
>
> A property P x has at W is hypothetical if whether x has P or not depends on how x could or would have been in other worlds.

Then, that α and β are contingent is defined as follows (ibid., p. 306, p. 309):

> Contingency: α and β are contingent iff they share their categorical properties.

This means if α and β are contingent at W, the ways α and β are at W are the same. For example, in 1.4 at W α has *driving home* essentially and *being speedy* accidentally, and β has both essentially. Therefore, there is a difference in the modal status of the properties they have. However, they share categorical properties *driving home* and *being speedy* at W, so they are contingent there. That is, if we look at how α and β are at W (and ignore how they are in other worlds), there is no difference in (categorical) properties they have at W.

2.2 Distinction between Mental Events and Their Physical Determinates

According to Yablo, a mental event m is a determinable of its physical determinate (realizer) p. In other words, p is m's refinement. For example, for p (m's refinement) to be a certain physical state is for m to be in pain, not *simpliciter*, but in a specific way. But what does this mean? To get a clear picture about this, suppose α (x's being in pain) has three physical realizers β, γ, δ, and each has its own specific physical property type P_1, P_2, P_3 respectively. Also, let the (cumulative) properties which β, γ, δ share be $\mathbb{P}$. Among others, $\mathbb{P}$ includes *being extending* (E), *being spaciotemporal* (S), *being in pain* (M). Then we can get M_2 below (just three properties E, S, and M in $\mathbb{P}$ are listed here):

$$\mathcal{W} = \{W_1, W_2, W_3, W_4\},\ \mathcal{D} = \{\alpha,\beta,\gamma,\delta\}$$

$$\mathcal{D}(W_1) = \{\alpha,\beta\},\quad \mathcal{D}(W_2) = \{\alpha,\beta\},\quad \mathcal{D}(W_3) = \{\alpha,\gamma\},\quad \mathcal{D}(W_4) = \{\alpha,\delta\}$$

$$E(W_1) = \{\alpha,\beta,\gamma,\delta\},\ E(W_2) = \{\alpha,\beta,\gamma,\delta\},\ E(W_3) = \{\alpha,\beta,\gamma,\delta\}, E(W_4) = \{\alpha,\beta,\gamma,\delta\}$$

$$S(W_1) = \{\alpha,\beta,\gamma,\delta\},\ S(W_2) = \{\alpha,\beta,\gamma,\delta\},\ S(W_3) = \{\alpha,\beta,\gamma,\delta\}, S(W_4) = \{\alpha,\beta,\gamma,\delta\}$$

$$M(W_1) = \{\alpha,\beta,\gamma,\delta\}, M(W_2) = \{\alpha,\beta,\gamma,\delta\}, M(W_3) = \{\alpha,\beta,\gamma,\delta\},M(W_4) = \{\alpha,\beta,\gamma,\delta\}$$

$$P_1(W_1) = \{\alpha,\beta\},\quad P_1(W_2) = \{\alpha,\beta\},\quad P_1(W_3) = \{\beta\},\quad P_1(W_4) = \{\beta\}$$

$$P_2(W_1) = \{\gamma\}, \quad P_2(W_2) = \{\gamma\}, \quad P_2(W_3) = \{\alpha, \gamma\}, \quad P_2(W_4) = \{\gamma\}$$
$$P_3(W_1) = \{\delta\}, \quad P_3(W_2) = \{\delta\}, \quad P_3(W_3) = \{\delta\}, \quad P_3(W_4) = \{\alpha, \delta\}$$

At W_1 and W_2, β determines α, so they are contingent. That is, they share categorical properties E, S, M, P_1 there. Similarly, at W_3 γ determines α, and they share categorical properties E, S, M, P_2 there. At W_4 δ determines α, and they share categorical properties E, S, M, P_3 there. About hypothetical properties, the important points are these: α has E, S M essentially, and P_1, P_2, P_3 possibly. Also, it has P_1 at W_1 and W_2 accidentally, P_2 at W_3 accidentally, and P_3 at W_4 accidentally. By contrast, β has P_1 essentially, γ has P_2 essentially, and δ has P_3 essentially. Therefore, the difference between α and its physical realizers β, γ, δ is that α accidentally has the properties its physical realizers have essentially.(3)

In general, (i) a mental event α has $\mathbb{P}$ essentially, and (b) if a physical realizer p such as β determines α at W, then α has $\mathbb{E}_X(p) - \mathbb{E}_X(\alpha)$ accidentally at W. This implies that α and its physical realizers share some physical and essential properties, and their differences are only in the modal status of the remaining properties. If we accept that E and S in $\mathbb{P}$ are typical properties physical events have essentially, then α is a 'physical' event in a sense. Let's say that mental events like α are *flexibly* physical because α is modally more *flexible* than its physical realizers: α has P_1, P_2, P_3 possibly. At the same time, there is another sense of 'physical' applied to β, γ, δ. Let's say that physical realizers are *rigidly* physical because they are more specific (or modally less flexible): β has P_1 essentially, and this makes it impossible for it to have P_2, P_3. This situation is also true of γ, δ.

Therefore, while mental events and their physical realizers (determinates) are distinct, this does not imply that mental events are not physical because their difference is within one and the same ontological category. The category of physical events includes at least modally more flexible events like α, and modally more rigid events like β, γ, δ.(4) Their difference is not in that either has some properties the other does not, but in that some of their shared properties have different modal status. In short, a mental event α and its physical realizers differ just in the hypothetical aspects of their shared properties.

3. Determination of Properties

According to Yablo, mental properties are *immanent* in physical properties, or they are in the intensive part/whole relation (3.1). However, what these relations mean is not clear, so I'll discuss Funkhouser's theory of the determinable-determinate relation between properties to get a clear picture of the determination of properties in Yablo's theory (3.2-4).

3.1 Immanence, Intensive Part/Whole Relation, and Refinement

Yablo compares two kinds of relation *emergence* and *immanence* to explain the necessitation of Property A by Property B (Yablo, 1992b, 1997, p. 230 fn. 29, p. 281 fn.21):

> A is emerging from B iff B is prior to A, and *brings about* A in an infallible way.
>
> A is immanent in B iff certain conditions for x to be B are inherently for it to be A.

These are rough characterizations, but if A is immanent in B, then B necessitates A because certain conditions for something to be B are inherently for it to be A (not because B *brings about* A). For example, if being at temperature 95 ℃ (T) is immanent in the certain micromechanical property P_m, then P_m necessitates T because certain conditions for, say, this tea to be P_m are inherently the conditions for it to be T. However, what 'conditions for B are *inherently* conditions for A' means is not clear.

Also, Yablo compares two kinds of relation, *extensive* and *intensive* part/whole relation, to find candidates for the intimacy between mental and physical states (Yablo, 2000, 2001, p. 37, p. 67):

> α is an extensive part of β iff α is what we get when β is confined to just certain spaciotemporal positions.
>
> α is an intensive part of β iff β is what we get when α is confined to just certain possible worlds.

Extensive wholes exceed their parts in a spaciotemporal size, and intensive wholes are refinements of their parts. For example, your birth (your hand) is an extensive part of your life (body), and Mary's driving home (Socrates's drinking the hemlock) is an intensive part of her speeding home (his guzzling the hemlock).

As Walter says, perhaps for A to be immanent in B is for x with A to be an intensive part of x with B (Walter, 2007, p. 233). If this is right, we might combine immanence and intensive part/whole relation to talk about *properties*. Suppose β is α's refinement, then roughly

> A is immanent in B iff $B \in \mathbb{E}_X(\beta) - \mathbb{E}_X(\alpha) \wedge A \in \mathbb{E}_X(\alpha) \wedge A \notin \mathbb{E}_X(\beta) - \mathbb{E}_X(\alpha)$

For example, in M_2 $\mathbb{E}_X(\alpha)$ is $\{E, S, M\}$ and $\mathbb{E}_X(\beta)$ is $\{E, S, M, P_1\}$, so E, S, M are immanent in P_1. However, the reason why they are immanent in P_1 is still unclear. This means we need a theory for talking about relations between properties.

3.2 Determination Dimension and Non-Determinable Necessity

According to Funkhouser, a property has two different kinds of features: determination dimensions and non-determinable necessities (Funkhouser, 2006, pp. 551-2). Generally, if a property P is a determinable of a property Q, Q is P in a certain way. In other words, P is determined with respect to some particular features. For example, *red* is a determinable of *scarlet*, *vermilion*, *pink*, and they are red in a certain way. In this case, *red* is determined with respect to hue, value, and chroma. Also, *triangular* is a determinable of *equilateral-triangular*, *isosceles-triangular*, *right-triangular*, and they are triangular in a certain way. In this case, *triangular* is determined with respect to 3 side lengths. The features like these with respect to which a property is determined are called *determination dimensions*.

In addition to determination dimensions, determinables and determinates share some other features. For example, triangles are 3-sided, closed, plain figures, and all triangles must meet these requirements. Here, one important thing is that all triangles must have these features, but *triangular* is not determined along these features. Rather, these features do not permit degree or variation. In fact, triangles cannot differ in their 3-sidedness. This kind of feature which allows no degree or variation is called a *non-determinable necessity*. Therefore, determinates of a determinable are the same in terms of their non-determinable necessities, but differ along their values of the shared determination dimensions.

3.3 Mathematical Model and Property Space

We can construct a mathematical model of determination (ibid., p. 554). Each determinable is determined along n determination dimensions. Thus, we can regard each determination dimension as an axis, and form n-dimensional spaces for a determinable X with n determination dimensions. Each instance of X corresponds to a unique point in this n-dimensional spaces. The instances which correspond to the same point have the same values of n determination dimensions, so they are exactly similar in all respects relevant to individuating that kind. For example, *triangular* is determined along 3 side lengths, so a 3-dimensional space is formed for *triangular*. Each instance of *triangular* occupies a unique point in this space: one instance has 2cm for all the values of 3 side lengths, and another has 2cm for those of 2 side lengths and 3cm for the value of the remaining one length. If there is a third instance which has 2cm for all the values of 3 side lengths, then the first instance and the third instance exactly resemble in all respects for individuation: they are both equilateral triangles with 2cm side lengths.

In this picture, a property ranges over a n-dimensional space that is called a *property space*. For example, color properties are 3-dimensional: hue, value, and chroma are regarded as x, y, z coordinates. Now we can characterize determination based on a property space:

> Color property C determines color property D iff C's property space is a proper subset of D's 3-dimensional property space.

For example, in Munsell color system, a specific color property is expressed by three variables: scarlet is expressed by '7R 5/14'. In 'x y/z', 'x' is a variable for hue, 'y' and 'z' are variables for value and chroma respectively. In the case of *colored*, x, y, z in 'x y/z' can take any possible values: x can be 4R or 4.5PB. Therefore, the property space of *colored* is the whole of the 3-dimensional space for hue, value, and chroma. In the case of *red*, y and z can take any possible values, but x must include R like '2R' and '9R'. Therefore, the property space of *red* is a proper subset of that of *colored* because the possible values of x for *red* are limited. In the case of *scarlet*, it is expressed by '7R 5/14', so x, y, z already have its specific values. Thus, the property space of *scarlet* is a proper subset of that of *red*.

3.4 Conditions for Determination of Properties

Funkhouser offers the following necessary and sufficient conditions for determination (ibid., p. 556):

> Property B determines property A iff
> (1) A and B have the same determination dimensions.
> (2) B has the non-determinable necessities of A.
> (3) The range of determination dimension values for B is a proper subset of the range of determination dimension values for A.

This says that the relation 'being a proper subset of' is the core of determination.

Let's think about a determinable *triangular* and its determinate *equilateral-triangular*. Both *triangular* and *equilateral-triangular* have the same determination dimensions, namely 3 side lengths. *Equilateral-triangular* has the non-determinable necessities of *triangular*: 3-sided, closed, plain-figured. The range of determination dimension values for *triangular* is $\{(l_1, l_2, l_3) \in \mathbb{R}^3 \mid 0 < l_1, l_2, l_3,\ l_1 < l_2 + l_3,\ l_2 < l_1 + l_3,\ l_3 < l_1 + l_2\}$ and that of determination dimension values for *equilateral-triangular* is $\{(l_1, l_2, l_3) \in \mathbb{R}^3 \mid 0 < l_1, l_2, l_3,\ l_1 = l_2 = l_3\}$. Therefore, the range of *equilateral-triangular* is a proper subset of that of *triangular*.

4. Distinction between Mental Properties and Their Physical Determinates

Based on Yablo's theory of essence and Funkhouser's analysis of determination of properties, let's get a clear picture of the relations between mental/physical properties in Yablo's theory. Let's consider P_1, P_2, P_3 and M in M_2. First of all, $\mathbb{E}_X(\alpha)$ is $\{E, S, M\}$ and $\mathbb{E}_X(\beta)$ is $\{E, S, M, P_1\}$, and E and S do not permit degree or variation. Therefore we can say E, S are their shared non-determinable necessities. Also, suppose, with Yablo, that M has a physical determination dimension.[(5)] Then, the range of the determination dimension values for M is $\{P_1, P_2, P_3\}$, and that of the determination dimension values for P_1 is $\{P_1\}$. Therefore, P_1 determines M. In the same way, P_2 and P_3 determine M.

In order for M and P_i ($i = 1, 2, 3$) to be in the determinable/determinate relation, M and P_i must be in the same category. The non-determinable necessities make this happen, and in M_2 they are E, S and other typical features of physical properties. Therefore, the category to which M and P_i belong and in which the determinable/determinate relation stands for them is physical in a sense. This does not imply that M and P_i are not distinguished. M is flexible (more wide-ranging) than its physical realizers: it is possible for instances of M to be P_1, P_2, P_3. Thus, just as in 2.2 we can say that mental properties are *flexibly* physical. By contrast, P_1, P_2, P_3 are less flexible (narrow-ranging): it is impossible for instances of P_1 to be P_2 or P_3. This situation is true of P_2, P_3. Again just as in 2.2, we can say that they are *rigidly* physical. Therefore, the category of physical properties includes physically wide-ranging properties like M, and narrow-ranging properties like P_1, P_2, P_3. Their difference is within the same category: the range of M is more wide-ranging than that of P_1, P_2, P_3.

5. Conclusion

According to Yablo, mental events are determinables of their physical determinates (realizers). In other words, a physical determinate p of a mental event m is m's refinement. The important point here is this: while m has some properties essentially and other properties accidentally, p essentially has all the properties m has. This brings m and p into the same ontological category: mental events and their physical determinates differ in that the former is flexibly physical and the latter is rigidly physical. Also, According to him, mental properties are determinables of their physical determinates (realizers). If this is true, since determinables and determinates must share non-determinable necessities, mental properties and their physical determinates share typical features of physical properties such as *being extending* and *being spaciotemporal*. This leads m and p to go into the same ontological category: mental properties and their physical determinates differ in that the former is flexibly physical and the latter is rigidly physical.

In this way, Yablo's view is a token- and property-distinct theory of the mental and the physical. However, this distinctness in his theory is quite different from the distinctness in an emergentist view in which content properties like *hoping that this will helpful* are essentially normative, and physical or neurophysiological properties lack this feature. In other words, content properties and physical properties might belong to different ontological categories. Therefore, in order for his view to be a genuine alternative to emergentist views, the normative aspect of content properties must be explained away. However, this is far from obvious and should be investigated separately in another place.

Notes

(1) Generally, α has the kind property of P iff α has P (α is P). For example, Brutus's stabbing Caesar is an event of a certain kind, namely stabbing, so it also has the property of *being the kind of stabbing*. If α has the property P essentially, then it has the property of *being the kind of P* essentially.
(2) Hereafter, it is assumed that every world has access to every other.
(3) M_2 is quite simple, so this is the only difference. However, usually α and its refinement differ in their causal properties, probabilistic properties, and counterfactual properties (ibid., p. 305).
(4) Their difference in modal flexibility ultimately comes from the difference in the range of the determination dimension values of M and its physical realizers P_1, P_2, P_3. What makes it possible for α to have P_1, P_2, P_3 possibly and to be a flexibly physical event is that (a) α essentially has a flexibly physical property M whose range is $\{P_1, P_2, P_3\}$ and (b) α accidentally has a rigidly physical properties P_1, P_2, P_3 whose range is $\{P_1\}, \{P_2\}, \{P_3\}$ respectively. See sec.4.
(5) This is controversial. The current ongoing debates focus on whether the determinable/determinate relation really holds for the mental/physical. Whether this assumption is true or not depends on what conditions are to be imposed on determination. Funkhouser himself is an opponent of Yablo's idea.

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