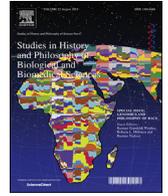




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Philosophy of race meets population genetics



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ABSTRACT

In this paper, I respond to four common semantic and metaphysical objections that philosophers of race have launched at scholars who interpret recent human genetic clustering results in population genetics as evidence for biological racial realism. I call these objections ‘the discreteness objection’, ‘the visibility objection’, ‘the very important objection’, and ‘the objectively real objection.’ After motivating each objection, I show that each one stems from implausible philosophical assumptions about the relevant meaning of ‘race’ or the nature of biological racial realism. In order to be constructive, I end by offering some advice for how we can productively critique attempts to defend biological racial realism based on recent human genetic clustering results. I also offer a clarification of the relevant human-population genetic research.

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“Thus there appears to be a mismatch: racial groups are conceptually organized in part by skin color, while human breeding populations are not” (Glasgow, 2009, 97).

“What “we” in public discourse call race is not a natural or genetic category” (Haslanger, 2012, 307).

1. Introduction

Recent work in population genetics has problematized the received view about race in the philosophy of race. By *philosophy of race* I mean philosophical work on the topics of race or racism done by professional philosophers. Philosophers of race are a diverse bunch. Some were trained as philosophers of language (e.g. Anthony Appiah, Christopher Hom, Luvell Anderson, etc.); some were trained as moral or political philosophers (e.g. Bernard Boxill, Kathryn Gines, Joshua Glasgow, Charles Mills, etc.); some were trained as epistemologists (e.g. Linda Alcoff, Naomi Zack, etc.); some were trained as metaphysicians (e.g. Sally Haslanger, Jeremy Pierce, etc.); some were trained as philosophers of science (e.g. Lisa Gannett, Koffi Maglo, Robin Andreasen, etc.); and the list continues. However, despite the diversity among philosophers of race, most

philosophers of race have arrived at the same metaphysical conclusion about race: that it’s not the case that race is biologically real. Suppose we call this view *biological racial anti-realism*. Then, the received view about race in philosophy of race is undoubtedly biological racial anti-realism. However, I should be clearer about what I am saying here.

As Robin Andreasen (1998, 218) has clarified, debates about the biological reality of race are sometimes about whether biology vindicates ordinary racial classification, and sometimes about whether humans can be validly divided into “biological races”—by which she means races understood in some biological sense of ‘race’, such as subspecies. Due to the demographics of philosophers of race (mostly Americans and mostly not philosophers of science), the primary concern among philosophers of race has been on whether biology vindicates ordinary racial classification, and, in particular, the ordinary meaning of ‘race’ in the contemporary United States of America (US).¹ So, the most charitable way to understand the received view about race in philosophy of race is as contextualized to racial discourse that uses the ordinary meaning of

¹ For evidence that most philosophers of race contextualize their race theory to the ordinary meaning of ‘race’ in the contemporary US in whole or in part, see: Outlaw (1990, 58, 60, 78), Zack (1994, 14), Appiah (1996, 38, 41), Mills (1998, 42), Blum (2002, 133–135), Sundstrom (2002, 96), Corlett (2003, 1, 6), Andreasen (2004, 437), Stubblefield (2005, 3), Alcoff (2006, 10), Glasgow (2009, 3), Haslanger (2012, 308), Taylor (2013, 20, 82), and Spencer (2014, 1025).

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'race' in the contemporary US (hereafter, *the US meaning of 'race'*), and for that reason alone I will restrict my focus to this interpretation of biological racial anti-realism.² Thus, we can restate the received view about race among philosophers of race as the view that it's not the case that race, according to the US meaning of 'race', is biologically real.

Despite the popularity of biological racial anti-realism among philosophers of race, recent work in population genetics poses a serious problem for the received view. In short, certain levels of human population structure look like they consist entirely of *US racial groups* (racial groups according to the US meaning of 'race'), which suggests—though does not imply—that race, in its US meaning, is biologically real after all. In fact, some scholars, such as Neil Risch, Burchard, Ziv, and Tang (2002, 6) and Spencer (2014, 1033) have explicitly argued that one specific level of human population structure reveals “US racial groups”.

Nevertheless, philosophers of race have, for the most part, rejected the claim that these new population-genetic results overturn the received view of biological racial anti-realism, and they have defended the received view using three philosophical routes: semantics, metaphysics, and methodology. The semantic critics argue that, according to what 'race' means in the contemporary US, the human populations picked out in population-genetic research are simply not *rac*es, and thus, this population-genetic research is not really about *race*. In other words, according to these critics, even though population geneticists regularly use names like 'Native American', 'Asian', and 'Pacific Islander' to describe certain human populations, it would be an equivocation fallacy to interpret population geneticists as talking about the same Native Americans, Asians, and Pacific Islanders that ordinary Americans call 'races'. While philosophers have advanced several reasons for the *semantic mismatch* between human population terms and US race terms, I will only discuss the two most popular objections.³ The first semantic objection I will discuss is the widely held view that US racial groups must be “discrete”; and the second semantic objection I will discuss is the widely held view that US racial groups must be distinguishable according to “visible physical features” (Glasgow, 2009, 20; Zack, 2002, 87). I call the first the *discreteness objection* and the second the *visibility objection*.

The metaphysical critics argue that even if the semantic objections do not succeed, human genetic clustering results do not support the *biological reality* of race. Again, while there are more than a few metaphysical objections that philosophers of race have launched, I will only address the two most popular objections. The first is that in order for US racial groups to be biologically real, they need to form a *very important* biological classification, such as a level of “subspecies” or “clades” (Maglo, 2011, 370; Zack, 2002, 37).⁴ The second is that US racial groups are not biologically real because they are not *objectively real* in the sense of existing independently of human interest, belief, or some other mental state of humans (Sundstrom, 2002, 93; Zack, 2002, 5). I call the first objection the *very important objection* and the second the *objectively real objection*.

The methodological critics launch epistemological concerns about the experimental design, execution, or interpretation of the relevant population-genetic research. For instance, Serre and Pääbo (2004) have questioned the sampling strategy of the relevant population-genetic research. Kalinowski (2011) has questioned the accuracy of the clustering software used in the relevant population-

genetic research, Maglo (2011) has questioned the robustness of the relevant results, and Kaplan and Winther (2013, 2014) have highlighted the Duhemian underdetermination that haunts any racial interpretation of the results. Though the methodological concerns are important, I will limit my discussion to the semantic and metaphysical concerns for two reasons. First, the semantic and metaphysical concerns are no less important than the methodological concerns, and, second, the semantic and metaphysical concerns have been discussed much less than the methodological concerns in the literature.

The purpose of this paper is to show that each of the four semantic or metaphysical objections mentioned above, each of which purports to offer a reason for rejecting the claim that recent human genetic clustering results support biological racial realism, stems from implausible semantic assumptions about the US meaning of 'race' or implausible metaphysical assumptions about what 'biological racial realism' should mean. However, in order to be constructive, I will follow my critique with advice about how philosophers of race can productively critique these new attempts to revive biological racial realism. I will begin by summarizing the population-genetic research that has caused all of the fuss.

2. Human population structure looks racial

The recent work in population genetics that poses a serious challenge to biological racial anti-realism originated with the implementation of a new technique in population genetics for identifying infraspecific population structure. To be clear, population geneticists consider it an important research project to determine a species' “population structure,” which is its hierarchical levels of biological populations (Hartl & Clark, 2007, vi–x). Population geneticists usually start by identifying all of the “local populations” (or “demes”) in a species, and lump these populations into more inclusive population groups until they reach the species level (Hartl & Clark, 2007, 46).⁵

Population geneticists have used this new technique for identifying infraspecific population structure to assess population structure in all sorts of predominantly sexually reproducing species, such as common chimpanzees, chickens, Polynesian tiger mosquitos, and Japanese barberry plants. However, the technique and clustering results derived from the technique only became controversial outside of population genetics when the technique was applied to humans. So, what is this new technique? Unsupervised, fuzzy genetic clustering—or *UFG clustering* for short. UFG clustering is *unsupervised* insofar as population assignment is done by a computer. UFG clustering is *fuzzy* insofar as population membership is fuzzy in a fuzzy set-theoretic sense. In other words, in UFG clustering, individuals possess a grade of membership in a population that corresponds to a real number in the interval [0, 1] (Zadeh, 1965, 339). With that said, population geneticists tend not to use the word 'fuzzy' to describe population memberships; they prefer to use the word 'admixed' instead (Pritchard, Stephens, & Donnelly, 2000, 947; Tang, Peng, Wang, & Risch, 2005, 289).

Before the invention of UFG clustering algorithms, such as *structure*, *frappe*, *admixture*, and *mStruct*, population geneticists only used “distance-based methods” to sort individuals into populations (Pritchard et al., 2000, 946). Distance-based methods used measures of biological distance (e.g. F_{st} genetic distance) among local populations or organisms to construct a distance matrix. Then, that matrix was converted into a visual graph, such as a tree (as in UPGMA tree reconstruction) or a scatter plot (as in

² The sense of 'racial discourse' that I am using can be found in Spencer (2014, 1027).

³ I borrow the “mismatch” jargon from Mallon (2006, 533).

⁴ I borrow the “very important” jargon from Michael Hardimon (2012, 270–271).

⁵ In population genetics, a *local population* is a maximally inclusive group of randomly mating conspecific organisms (Hartl & Clark, 2007, 46).

multidimensional scaling or “MDS”).⁶ Finally, population structure was inferred from the visual graph.

While there are several virtues to distance-based population structure analysis, the method generates problems that UFG clustering does not have. For one, representing population structure using scatter plots, as is done in MDS, requires populations to be identified by sight as the clusters on the plot.⁷ But that allows an additional dimension of subjective bias that is not possible in unsupervised population assignment. Of course, the latter does not mean that UFG clustering is not susceptible to subjective bias. It just means that one dimension of possible subjective bias is removed in UFG clustering by making population assignment unsupervised.

Next, representing population structure using tree graphs makes it difficult to recognize “mixed populations” and quantify their “admixture” (Cavalli-Sforza, Menozzi, & Piazza, 1994, 24). For instance, in Cavalli-Sforza et al.’s (1994, 78) use of UPGMA tree reconstruction, they cluster Ethiopians exclusively with Sub-Saharan Africans despite the fact that Ethiopians are known to be a “mixed” population.⁸

Unlike distance-based methods, UFG clustering removes the need for scientists to visually detect populations, and can identify admixed populations with quantitative precision. While the exact details and model assumptions of UFG clustering algorithms vary, and are far too detailed to fully explain here, detailed explanations of individual UFG clustering algorithms can be found in the papers of their creators. For example, *structure* is explained in-depth in Pritchard et al. (2000), and *frappe* is explained in-depth in Tang, Peng, et al. (2005). Also, critical discussions of important model assumptions frequently made in UFG clustering algorithms can be found in Weiss and Long (2009), Winther (2014), and Winther et al. (2015). Nevertheless, a brief summary of how UFG clustering works is below.

Much like the fuzzy *c*-means clustering algorithm in fuzzy set theory, UFG clustering algorithms attempt to generate an optimal fuzzy partition of *K* parts using *N* objects by minimizing variation within each part.⁹ However, in the case of UFG clustering, the objects are organisms and the variation is genomic. UFG clustering also needs genomic data that exhibits lots of variation (e.g. microsatellites, single-nucleotide polymorphisms, etc.) and hypothesized “ancestral populations” to either facilitate or enhance the accuracy of partitioning (Tang, Peng, et al., 2005, 294, 297).¹⁰ Since there are infinitely many possible fuzzy *K* partitions for any set of objects, UFG clustering algorithms are designed to obtain approximately correct solutions by methodically searching for an optimal fuzzy *K* partition by starting the search from scratch at different points. Each search for an optimal fuzzy *K* partition is called an “iteration” of the algorithm, and independent searches are called “runs” (Rosenberg, 2011, 674).

Since UFG clustering can theoretically be used to generate $N - 1$ levels of fuzzy *K* partitions (where $N \geq K \geq 2$), population geneticists typically attempt to identify as many optimal fuzzy *K* partitions as their genomic data permit. Each level of “genetic clusters”

(as they are called)⁶ is strictly speaking just a partition of genetic clusters. However, coupled with the right auxiliary assumptions (e.g. no sampling bias) and sufficient cross-checking (e.g. ruling out isolation-by-distance as the sole cause of clustering), population geneticists can validly use UFG clustering results to infer a species’ population structure. Furthermore, many population geneticists—rightly or wrongly—consider the genetic clusters retrieved from human UFG clustering to be “continental populations” or “geographic populations,” so that is how I will talk about the results in this paper (Bamshad et al., 2003, 584–585; McEvoy et al., 2010, 297).

The first use of a UFG clustering algorithm on a worldwide sample of humans came from Noah Rosenberg et al. (2002).¹¹ Using 377 autosomal microsatellite loci from 1,056 humans representing 52 worldwide human ethnic groups, Rosenberg et al. (2002) used *structure* to identify a hierarchy of human genetic clusters from $K = 2$ to $K = 6$.¹² While there were lots of interesting results from Rosenberg et al.’s UFG clustering, the result that challenged biological racial anti-realism was the clustering result at $K = 5$. At $K = 5$, Rosenberg et al.’s human genetic clusters corresponded to groups of people anchored by the indigenous people of the following regions: Sub-Saharan Africa, North Africa and Eurasia west of the Himalayas, Eurasia east of the Himalayas, the Americas, and Oceania. Due to their geographic affiliations, population geneticists came to call these clusters ‘Africans’, ‘Eurasians’, ‘East Asians’, ‘Native Americans’, and ‘Pacific Islanders’, respectively.¹³ Furthermore, Rosenberg et al.’s $K = 5$ result is robust if one uses a worldwide sample of human ethnic groups. It has been reproduced in 69% of worldwide human genetic clustering studies since 2002 using different sets of genomic polymorphisms, humans, human ethnic groups, and clustering algorithms.¹⁴

Population geneticists immediately noticed that $K = 5$ human populations *look like* US racial groups. For example, early on, Sarah Tishkoff and Kenneth Kidd (2004, S6) said that “The emerging picture is that populations do, generally, cluster by broad geographic regions that correspond with common racial classification (Africa, Europe, Asia, Oceania, Americas).” This apparent match led some biomedical scientists (e.g. Burchard et al., 2003) and some philosophers of race (e.g. Spencer, 2014) to use Rosenberg et al.’s $K = 5$ result to revive biological racial realism. One other philosopher of race, Michael Hardimon (2012, 2013), has also expressed support for biological racial realism due to recent human

¹¹ By a *worldwide* sample of humans, I mean a sample of humans from all continents that humans inhabit.

¹² The sample was stratified by ethnic group in order to approximate a representative sample of human local populations.

¹³ For evidence, see Zhivotovsky, Rosenberg, & Feldman (2003, 1182), Rosenberg, Mahajan, & Feldman (2005, 662, 670), and Friedlaender, Friedlaender, & Weber (2008, 173–176).

¹⁴ Besides Rosenberg et al. (2002), Rosenberg et al.’s $K = 5$ result has appeared in Zhivotovsky et al. (2003), Ramachandran, Rosenberg, & Feldman (2004), Rosenberg et al. (2005), Bastos-Rodrigues, Pimenta, Pena, Kim, Conrad et al. (2006), Wang et al. (2007), Li et al. (2008), McEvoy et al. (2010), Kim et al. (2011), and Pemberton et al. (2013). However, it did not appear in Friedlaender et al. (2008), Jakobsson et al. (2008), Tishkoff et al. (2009), Xing et al. (2010), and Rosenberg (2011). Also, it is worth noting that whether population geneticists are *really* re-identifying the same continental populations in different UFG clustering studies is a nontrivial metaphysical question that can only be satisfactorily answered by clarifying the population concept that population geneticists are using in UFG clustering analyses. Nevertheless, the population geneticists that I have listed above as reproducing Rosenberg et al.’s $K = 5$ result do consider themselves to be reproducing Rosenberg et al.’s $K = 5$ result. For example, Li et al. (2008, 1100–1101) claim that they have reproduced Rosenberg et al.’s $K = 5$ result, and Pemberton et al. (2013, 902) claim that they have reproduced Li et al.’s $K = 5$ result.

⁶ ‘UPGMA’ stands for Unweighted Pair-Group Method using arithmetic Averages.

⁷ See, for example, Pemberton, DeGiorgio, & Rosenberg (2013, 898).

⁸ However, see Millstein (2015, p. 10) for some healthy skepticism about whether we should talk about people or populations as “mixed” or “admixed.” Also, one referee for this paper pointed out that another drawback of representing population structure using tree graphs is that it encourages readers to think of the populations as distinct lineages, even if that interpretation is not warranted by the data set.

⁹ For a nice summary of the fuzzy *c*-means clustering algorithm, see Zimmermann (2001, 290–296).

¹⁰ The hypothesized ancestral populations help the algorithms to calculate cluster centers.

population structure results, but he has shown less infatuation with the $K = 5$ result.¹⁵ It's also worth highlighting that Neil Risch et al. (2002, 3) endorsed Rosenberg et al.'s $K = 5$ result before Rosenberg et al. (2002) published their results by studying human genetic clustering results that were distance-based or did not use a worldwide sample of human ethnic groups.

Nevertheless, looks can be deceiving, and most philosophers of race have rejected that recent human population structure results provide evidence for biological racial realism because the results are either not actually about *races*, or do not support *biologically real* races. So, to that skepticism I now turn.

3. The semantic and metaphysical objections

3.1. The discreteness objection

The first semantic objection that philosophers of race have used to reject that any level of human population structure contains US racial groups is *the discreteness objection*. This objection states that no level of human population structure contains US racial groups because US racial groups are, by definition, “discrete” groups of people (Blum, 2002, 4; Corlett, 2003, 9; Zack, 2002, 43). Furthermore, by ‘discrete’, these critics mean “mutually exclusive” (Zack, 2002, 43).¹⁶ Below is the logic behind the discreteness objection.

First, it is assumed that US racial groups are, by definition, discrete. For instance, Lawrence Blum (2002, 151–152) puts it best when he says, “Race is an “all or nothing” matter: groups and individuals are either of a particular race or not...” Next, the latter assumption implies that in order for some level of human population structure to contain US racial groups, there needs to be at least one level of human population structure where each human has at most one population membership. However, since genetic admixture corresponds one-to-one with population membership in human population structure research, and humans do not possess a level of population structure where there is no genetic admixture, it follows that there is no level of human population structure that contains US racial groups.

I should clarify that the discreteness objection does not require there to be no genetic admixture in the human species in order for there to be US racial groups. That would be unreasonable. Rather, what the objection claims is that *membership* in US racial groups is different from *membership* in continental populations, since membership is “all or nothing” in the former, but a matter of degree in the latter (Blum, 2002, 151). Thus, strictly speaking, Blacks are not identical to Africans, Whites are not identical to Eurasians, Asians are not identical to East Asians, and so forth. These critics also tend to emphasize the role of “the one-drop rule” in American racial classification as evidence that Americans intend races to be discrete groups (Blum, 2002, 138; Corlett, 2003, 16; Zack, 2002, 92). This rule states that “an individual of any degree of sub-Saharan African ancestry is counted as black” (Blum, 2002, 138).

While the main proponents of the discreteness objection in the philosophy of race literature are Naomi Zack, Lawrence Blum, and J. Angelo Corlett; many biologists and critical race theorists also endorse the discreteness objection; so it is dialectically important.¹⁷ However, while the discreteness objection may have been

compelling in a different time period, it is no longer compelling today. This is because times have changed. In two recent studies, it has been shown that a critical mass of Americans rejects the idea that a person can only belong to one race.

First, Guang Guo et al. (2014) used *structure*, 162 ancestry informative markers, and a sample of 2,065 US college students to test the extent to which US adults use the one-drop rule in racial self-classification. Furthermore, due to its design, Guo et al.'s test of the one-drop rule doubles as a test of the extent to which US adults believe that races must be discrete. Guo et al. began by identifying each subject's membership grade in each $K = 5$ human population. Then, they looked at the subset of subjects who had 40–70% African ancestry and who self-reported ‘non-Hispanic’ and either ‘Black’ alone, ‘White’ alone, or ‘Black’ and ‘White’. Guo et al. looked at individuals with 40–70% African ancestry because they figured it was the range of African ancestry where people should know they are of mixed African ancestry. For example, both Dominicans and Cape Verdeans possess an average African ancestry in this range, and both look like people of mixed African ancestry.¹⁸

Next, Guo et al. administered a survey to these individuals where choosing more than one race was an option. All of these individuals should have reported Black alone if they were using the one-drop rule, and none should have reported more than one race if they believed that races were discrete. But they did neither. 62% of these subjects did not report Black alone, and they “primarily chose a multiracial classification” (Guo et al., 2014, 158–159, 167).

Jack Citrin, Levy, and Van Houweling (2014) conducted a different test of the use of the one-drop rule and the belief in discrete races among US adults. In Citrin et al.'s study, they surveyed a nationally representative sample of US adults on how President Barack Obama should have reported his race on the 2010 US census. 54–65% of subjects said that President Obama should have reported “both black and white” on the census across all test conditions (Citrin et al., 2014, 6). Thus, it is far from clear that US racial groups are, by definition, discrete.

3.2. The visibility objection

The second semantic objection that philosophers of race have used to reject the claim that any level of human population structure contains US racial groups is *the visibility objection*. In short, many philosophers of race believe that US racial groups are, by definition, “visible” due to distinctive traits, such as a certain skin color, facial features, or hair texture (Glasgow, 2009, 25, 33; Zack, 2002, 37). However, since human continental populations are defined according to geography and ancestry, not visible traits, this has led some philosophers of race to declare a “mismatch” between the meanings of US race terms and human population terms (Glasgow, 2009, 97). Naomi Zack puts the visibility objection best when she says:

These groups may roughly correspond to commonsense races, but the genetic material used to track group ancestry is not the genetic material responsible for those traits considered racial. The ancestral genetic tracking material has no effect on phenotypes, or biological traits of organisms, which would include the traits deemed racial, because the ancestral tracking genetic

¹⁵ Note that I did not include Neven Sesardic in this camp because he clarifies in his reply to Adam Hochman that his project “was *not* to prove the biological reality of race,” but merely to critique the arguments from opponents to genetic conceptions of race (Sesardic, 2013, 287).

¹⁶ Corlett (2003, 9) says that races must be “distinct” instead of “discrete,” but by that he means ‘mutually exclusive’ just like Blum and Zack.

¹⁷ See, for example, Graves (2004, xvi, 111, 118), Feldman & Lewontin (2008, 96–97), and Roberts (2011, 51, 53–54).

¹⁸ Dominicans, on average, possess 41.8% ($\pm 16\%$) African ancestry and Cape Verdeans, on average, possess 57% ($\pm 8\%$) African ancestry (Beleza et al. 2012, 4; Bryc et al. 2010, 8955). Both are autosomal estimates. However, Guo et al. were lucky here since many Dominicans are not aware that they have African ancestry. See Gates (2011, 119–145). Nevertheless, since Guo et al. excluded Hispanics from the subset, the Dominican anomaly is irrelevant.

material plays no role in the production of protein—it is not the kind of material that “codes” for protein production... Thus, in itself, the ancestral tracking genetic material is irrelevant to scientific racial identification, definition, or taxonomy, although it is, of course, highly useful for reconstructing the migrational histories of groups (Zack, 2002, 41).

The visibility objection has been explicitly advanced by Naomi Zack and Joshua Glasgow.¹⁹ However, the belief that US racial groups must be visible is widespread in philosophy of race.²⁰ Perhaps Glasgow (2009, 25) best captures this belief when he says: “*that each race by and large has a distinctive set of visible traits is conceptually non-negotiable.*”

While I think Zack, Glasgow, and other philosophers of race who believe that US racial groups must be visible are correct that *some* racial discourses require racial groups to be visible, it is simply not true that the latter is a requirement in US racial discourse. To show this, I only need to assume that Blacks and Pacific Islanders, as defined by the US Census Bureau (USCB), are groups of people that Americans acknowledge as *races*. Since 1.2 million Americans and 42 million Americans self-identified as “Pacific Islander” and “Black” on the 2010 US census, respectively, the latter is a safe assumption (Hixson, Hepler, & Kim, 2012, 4; Rastogi, Johnson, Hoeffel, & Drewery, 2011, 3).

According to the USCB, Blacks are the population group consisting of Sub-Saharan Africans, African Americans, Afro-Caribbeans, Afro-Latinos, and the like. Pacific Islanders, on the other hand, are the population group consisting of Melanesians, Polynesians, Micronesians, and perhaps Aboriginal Australians.²¹ There are two interesting facts about these two population groups.

First, Melanesians look like Blacks.²² Just like Blacks, Melanesians have a high frequency of dark skin pigmentation, curly black hair (and the ability to grow afros), full lips, round noses, etc. While there is a subgroup of Melanesians who grow blond afros, this subgroup is small compared to Melanesians as a whole.²³ The visible similarities between Blacks and Melanesians hold for a well-known set of evolutionary reasons. First, humans originated in Sub-Saharan Africa looking like Blacks (Jablonski & Chaplin, 2010, 8963). Next, during the out-of-Africa migration, humans dispersed to Melanesia using a southern route along Eurasia (Cavalli-Sforza & Feldman, 2003, 270). Finally, geographic isolation and natural selection preserved Melanesians’ ancestral Black character states, such as dark skin pigmentation (Jablonski & Chaplin, 2000, 75).

However, I should clarify what I am saying and what I am not saying. I am not saying that all Blacks and all Melanesians look alike. Rather, what I am saying is that the common visible phenotypes among Melanesians fit nicely within the range of variation for the common visible phenotypes among Blacks. For instance, Jablonski and Chaplin (2000, table 6) report that the average skin reflectance (at 685 nm) among indigenous Papua New Guineans ranges from 31.20 in the Lufa district to 41.00 at Port Moresby, and the average skin reflectance (at 685 nm) among indigenous Sub-Saharan Africans ranges from 19.45 in the Chopi people of

Mozambique to 50.96 in Cape South Africa. Hence the variation in dark skin pigmentation among indigenous Papua New Guineans falls within the variation in dark skin pigmentation among indigenous Sub-Saharan Africans.

The second interesting fact is that, according to the most recent national census results from Oceanic countries and US government data on foreign countries, it turns out that the *overwhelming majority* (~75%) of Pacific Islanders are Melanesians.²⁴ Combined with the first fact, it follows that *most* Pacific Islanders look like Blacks, and so there are two US racial groups that do not “*by and large*” possess “*a distinctive set of visible traits*” (Glasgow, 2009, 25).

The reason why Zack, Glasgow, and other American philosophers may have missed the fact that neither Blacks nor Pacific Islanders “*by and large*” possess a “*distinctive set of visible traits*” is because the US has an unrepresentative sample of Pacific Islanders. Most Pacific Islanders are Melanesian (~75%), but most Pacific Islander Americans (≥78%) are Polynesian or Micronesian (Hixson et al., 2012, 14). Thus, current US racial discourse does not support the claim that each race, by and large, must possess a distinctive set of visible traits.

3.3. The very important objection

The first two objections I discussed were semantic, but the next two will be metaphysical.

The first metaphysical objection that philosophers of race have used to reject the claim that any level of human population structure contains biologically real races is *the very important objection*. This objection states that in order for US racial groups to be biologically real, they need to form a *very important* biological classification. For instance, both Naomi Zack (2002, 37, 42) and Adam Hochman (2013, 331; 2014, 81) doubt that human continental populations are biologically real races because they fall short of being “*subspecies*.”²⁵ Moreover, Koffi Maglo (2011, 370) doubts that human continental populations are biologically real races because they fail to form “*clades*.”

When we dig deeper into this objection, we see that the real concern isn’t that the human continental populations commonly called ‘*races*’ by Americans fail to be subspecies or clades per se, but rather, that they fail to be very important to biology. For instance, Maglo’s (2011, 370) real aim is “*undermining the claim that race is a fundamental or primitive category in human population genetics*.” Also, Zack (2002, 39) clarifies her skepticism in the following way: “*Skepticism about a scientific foundation for race does not include denial of the ability to prescientifically identify those groups that are presumed to be races—what’s at issue is whether the groups are races in any scientific sense.*” Thus Maglo’s real concern is whether any ordinary racial classification is fundamental to human population genetics and Zack’s real concern is whether any ordinary racial classification picks out *biological races*.²⁶ Notice that both skeptics introduce a high standard for something to be a biologically real race. For something to be a biologically real race, it needs to be *very important* to contemporary biology.²⁷

The very important objection has its origin in Richard Lewontin’s (1972, 386, 388, 396) famous calculation of a very

¹⁹ For evidence, see Zack (2002, 41) and Glasgow (2009, 92–95).

²⁰ See, for example, Blum (2002, 99–100, 127), Alcoff (2006, 7), Taylor (2013, 89–90), and Kaplan and Winther (2013, 401).

²¹ Melanesians are the human ethnic groups indigenous to Fiji, New Caledonia, New Guinea, Solomon Islands, and Vanuatu. Also, while the USCB does not list Aboriginal Australians as an example of a Pacific Islander population group, according to the 2010 American Community Survey Code List, the USCB does lump “*Australian Aborigines*” with people of “*Pacific*” ancestry (USCB, 2010, 16).

²² See Sarich and Miele (2004, 134) for a discussion of this fascinating fact.

²³ For instance, Kenny et al. (2012, 554) report that just 5–10% of Solomon Islanders possess the alleles to grow blond afros.

²⁴ See the online [Supplementary material](#) for a discussion of how this calculation was made.

²⁵ For a biologist who defends biological racial anti-realism in this way, see Templeton (2013).

²⁶ This is Hochman’s real concern as well. See Hochman (2014, 82).

²⁷ For another philosopher of race who has endorsed the very important objection in print, see Blum (2002, 138). For a biologist and a critical race theorist who has endorsed it, see Graves (2004, 5) and Roberts (2011, 4), respectively.

small fraction of human genetic diversity occurring among seven “conventional” races—which was 6.3% according to 17 blood group genes and the Shannon information measure.²⁸ At the end of this article, Lewontin (1972, 397) memorably says, “Human racial classification is of no social value and is positively destructive of social and human relations. Since such racial classification is now seen to be of virtually no genetic or taxonomic significance either, no justification can be offered for its continuance.”

Even though Lewontin says “virtually no genetic or taxonomic significance” as opposed to “no genetic or taxonomic significance,” many philosophers of race have interpreted Lewontin’s calculation—and its subsequent verification by several population geneticists, including Rosenberg et al. (2002, 2381)—to be strong evidence against biological racial realism.²⁹ However, the mistake with the very important objection is that it adopts an unreasonably high standard for biological racial realism. There is no need for US racial groups to be subspecies or clades, have high genetic variation among them, or be fundamental categories in human population genetics just in order to be biologically real races. Rather, in order for US racial groups to be biologically real races, they just need to be races and biologically real.

The view I am advancing is that defending biological racial realism ontologically commits one to only the following claim: race, in the relevant meaning of ‘race’, is biologically real. If an object satisfies the latter condition, then one need not defend it as a classification of biological race (e.g. subspecies) or fundamental to human population genetics *as well* in order to defend biological racial realism. Furthermore, since the relevant meaning of ‘race’ in our case is the US meaning of ‘race’, if someone defends something as both *US race* (as we can call it) and biologically real, then that state of affairs is sufficient for her to be defending biological racial realism.³⁰ The reason why biological racial realism only requires the ontological commitments I’ve stated is because that’s all that’s needed to *negate* biological racial anti-realism as the view is commonly understood among philosophers of race. Below is an example that illustrates my point.

Recently, I have argued that the set of human populations that currently occupy the $K = 5$ level of human population structure simply is US race, and is also biologically real.³¹ Even if I am wrong about these two claims, I have offered a genuine defense of biological racial realism because I have succeeded in disagreeing with racial anti-realists—such as Appiah (1996), Blum (2002), and Glasgow (2009)—and I have succeeded in disagreeing with pure social constructionists about race—such as Alcoff (2006), Haslanger (2012), and Taylor (2013).

At this point, some supporters of the very important objection might complain that I am “watering down” the definition of ‘biological racial realism’ to an unacceptable extent (Hochman, 2014, 81). For instance, if we use the term ‘racial naturalism’ as interchangeable with ‘biological racial realism’, then Adam Hochman (2014, 86) argues that it’s not enough to negate biological racial

anti-realism in order to have an acceptable version of racial naturalism. Rather, in addition, racial naturalists must find “a biological reason for deciding how many races there are.” In Hochman’s (2014, 82) words, “What is important is that racial naturalism is strong enough to contrast with anti-realism about biological race, and that it is *consistent* with scientific naturalism. This is not because scientific naturalism is right, but simply because racial naturalism is a form of [scientific] naturalism.”

While Hochman (2014, 80–81) does not define ‘scientific naturalism’, he does say, “For an account of race to be naturalistic, it must be consistent with the standard scientific methodologies used to identify biological kinds below the species level.” Hence from Hochman’s viewpoint, an acceptable interpretation of ‘racial naturalism’ must use the methodologies of the natural sciences to define ‘race’ and ‘biologically real’, not just ‘biologically real’. Otherwise, one is left with “an unnaturalised racial naturalism” (Hochman, 2014, 86).

While Hochman’s claim that racial naturalism analytically entails a commitment to using science to define ‘race’ is interesting, I think he is reading too much into the word ‘racial naturalism’. Some other philosophers of race use ‘racial naturalism’ in a much less loaded way. For instance, according to Haslanger (2012, 300), “Naturalists hold that races are a natural division of human beings, that is, a division which rests entirely on natural properties of things.” Notice that Haslanger’s definition of ‘racial naturalism’ does not require that ‘race’ is defined by natural scientists, just that what ‘race’ picks out is “a natural division of human beings.” Furthermore, Haslanger (2012, 308) would not think of defining ‘racial naturalism’ in Hochman’s way because she is interested in race theory “that captures our ordinary use of the term.”

Nevertheless, in order to avoid confusion, I will refrain from using ‘race naturalism’ interchangeably with ‘biological racial realism’. Now that any allusion to scientific naturalism is removed, what reason do we have for requiring “a biological reason for deciding how many races there are?” Clearly, the answer is ‘none’. The relevant standard for determining what ‘race’ means in a particular biological racial realism depends on the racial discourse that anchors the debate, which in our case is US racial discourse.³²

3.4. The objectively real objection

The second metaphysical objection that philosophers of race have used to reject that any level of human population structure contains biologically real races is *the objectively real objection*. This objection states that US racial groups are not biologically real because they are not *objectively real* in the sense of existing independently of human interest, belief, or some other mental state of humans (Sundstrom, 2002, 93; Zack, 2002, 5). The two main proponents of this objection are Naomi Zack and Ron Sundstrom. Zack (2002, 4) equates “biologically real” with “natural, capable of origination without human invention, in need of no special cultural formation for their development, and, universal for *Homo sapiens*.” Zack (2002, 4) clarifies her position by saying, “... those who deny biological foundations for race do not in general deny the existence of human biological differences. Rather they claim that the *racial* aspects of some of these differences are culturally constructed ...” Sundstrom also aligns biological reality with a reality independent of certain mental states of humans. For Sundstrom (2002, 101, 94), a “real biological kind” is a kind that occurs “independently of human interest” and “is unified by some significant biological relation.”

²⁸ Lewontin’s seven “conventional” races were “Caucasians” (e.g. Armenians, French, Egyptians, Georgians, Pakistani, Hindi-speaking Indians, Syrians, Swedes, etc.), “Black Africans” (e.g. Kenyans, Liberians, Nigerians, Bantu, Ugandans, Madagascans, U.S. Blacks, etc.), “Mongloids” (e.g. Chinese, Japanese, Filipinos, Taiwanese, Thais, etc.), “Amerinds” (e.g. Blackfeet, Navaho, Eskimo, Aleut, Pueblo, Quechua, etc.), “Oceanians” (e.g. Papuans, Solomon Islanders, Samoans, Tongans, Palauans, Yapese, etc.), “South Asian Aborigines” (e.g. Andamanese, Onge, Irula, etc.), and “Australian Aborigines” (Lewontin, 1972, 387).

²⁹ For philosophers of race who use Lewontin’s result that there is greater genetic variation within folk races than among them as evidence against biological racial realism, see Zack (1993, 14), Appiah (1996, 68), and Blum (2002, 138), among others.

³⁰ See Mosley (1999, 80), Boxill (2004, 211), and Hardimon (2012, 271) for other philosophers of race who share my objection to the very important objection.

³¹ See Spencer (2014).

³² Hochman seems to be sympathetic to my definition of ‘biological racial realism’, as long as it’s not called ‘racial naturalism’. He prefers to call it “*realism about folk race*” (Hochman, 2014, 83).

Furthermore, based on these definitions, both Zack (2002, 52) and Sundstrom (2002, 105) reject that US racial groups are biologically real, even when understood as “breeding populations.”

The thought that biologically real entities exist independently of the mental states of humans is deeply entrenched in the philosophy of race. For instance, before the invention of UFG clustering algorithms, Charles Mills (1998, 45–46) defined “the most minimal sense” of biological racial realism as the view that “it is objectively the case—independent of human belief—that there are natural human races.” While the objectively real objection is thoughtful, it rests on the implausible metaphysical assumption that real biological entities and entities that exist because of the mental states of humans are mutually exclusive. Rather, in order to accurately capture the real entities of human biology, we need to embrace biologically real entities whose existence is dependent on human mental states, such as human beliefs and human interests.

For instance, consider the local populations of humans, such as the Yoruba, Kalash, Han, Hazara, and Suruí (Cavalli-Sforza, 2005, 338). Population geneticists consider local populations to be “the fundamental units of population genetics” because they are “the actual, evolving units of a species” (Hartl & Clark, 2007, 46). However, in humans, local populations are usually “ethnic groups” due to the social nature of human interbreeding and isolation (Cavalli-Sforza, 2005, 339). Furthermore, since the existence of human ethnic groups depends on human beliefs and interests, human population genetics would be in poor shape if the only entities that population geneticists were allowed to acknowledge must exist independently of human mental states.

What this means is that biological racial realism should not be contrasted with social constructionism about race, since some entities are biologically real exactly because they are socially constructed. Rather, biological racial realism should be contrasted with biological racial anti-realism, which is its logical negation. Thus, the interesting philosophical question isn’t whether US race is biologically real or “culturally constructed,” but rather, whether it is biologically real or *not* (Zack, 2002, 4).³³

4. Suggestions for moving forward

4.1. Question the use of the armchair approach

Though this paper has been rather critical of critics to biological racial realism based on recent human population structure results, I do think it is good to be skeptical of these new biological racial realisms. My main concern, however, is that the semantic and metaphysical skepticism has not been generated in a compelling way. So, in this section, I will suggest a few ways for how critics can productively question biological racial realism generated from recent human genetic clustering results.

First, philosophers of race ought to be much more critical of metasemantic assumptions than we have been in the past.³⁴ By a *metasemantic assumption* I mean a philosophical assumption about meaning. For instance, one epistemological assumption that is responsible for generating the discreteness and visibility objections is that personal intuitions are reliable sources of evidence for determining the US meaning of ‘race’. Glasgow (2009, 39) has aptly named this evidential strategy “the *armchair* approach.” For example, both Blum (2002, 100, 139–140) and Glasgow (2009, 28–35) use thought experiments based on personal intuitions to

generate their race theories, and Corlett (2003, 7) and Zack (2002, 26) appeal to their intuitions to arrive at “primitive race theory” and “common sense racial taxonomy,” respectively. However, are the ideas about race that a single philosopher holds representative of the total ideas about race in the American public? It’s unlikely. Rather, it’s likely that philosophers are merely clarifying an idiosyncratic idea of race by using personal intuitions to generate their race theories.

The use of personal intuitions as semantic evidence occurs on both sides of the debate as well. For instance, Hardimon (2013, 18), who has defended “the populationist concept of race” as a possible conceptual framework for making sense of human continental populations as biologically real races, justifies the racial nature of so-called “populationist races” by using what he calls “the ordinary concept of race.” However, in the paper where Hardimon (2003, 443) introduces the ordinary concept of race, he crucially relies on his personal intuitions to articulate the concept—such as when he uses his “Adam’s apples” thought experiment to refine the visibility criterion for race.

The solution to this problem is for philosophers of race to stop using their intuitions to generate race theories, and to use experimental or quantitative observational data in its place. For example, Glasgow (2009, 96) appeals to some well-executed experiments done by the USCB, the Kaiser Family Foundation, and the Pew Hispanic Center to raise a difficult empirical challenge to anyone who wants to argue that US racial groups are biological populations. In short, the empirical data that Glasgow presents make it hard to deny that Hispanics constitute a US racial group. However, the problem for biological racial realism based on human genetic clustering results is that Hispanics do not form a biological population at any level of human population structure discovered so far. Hua Tang, Quertermous, et al. (2005, 271) claimed to have isolated Hispanics as a human genetic cluster at $K = 4$, but this was later shown to be an artifact of sampling bias (Glasgow, 2009, 95).

4.2. Question the use of descriptivism

Second, philosophers of race ought to be much more critical of the *semantic* assumptions that ground our race theories. Particularly, many philosophers of race suppose, without any empirical evidence, that the US meaning of ‘race’ is descriptive. I am, of course, alluding to the widely acknowledged distinction in philosophy of language between “descriptive” and “referential” meanings (Perry, 2001, 3). I’ll use John Perry’s (2001, 4–32) jargon to introduce the distinction.

First, suppose an “identifying condition” is a condition that only one thing can satisfy, such as *being the oldest daughter of Barack Obama* (Perry, 2001, 4). Second, suppose ‘designate’ is a word for the relation that holds between a term and the object it stands for (Perry, 2001, 30). Next, suppose the *meaning* of a term t relative to a language L and a context C is the contribution t makes—either its identifying condition(s) or its designated object—to the conditions under which any statement in which t occurs is true (Perry, 2001, 18, 32).³⁵ In that case, we can say that a term t has a *referential* meaning relative to L and C if its meaning is the object it designates, and t has a *descriptive* meaning relative to L and C if its meaning is the identifying condition(s) assigned to it (Perry, 2001, 32). For example, in English, and relative to United States Postal Service ZIP code conventions, ‘94027’ has a referential meaning—namely, Atherton, California—because in order to figure out whether statements like

³³ For other examples of philosophers of race criticizing a sharp dichotomy between biological reality and socially constructed reality, see Outlaw (1996), Kitcher (1999), Gannett (2004), Kaplan (2010), and Kendig (2011).

³⁴ Notable exceptions are Glasgow (2009, 38–58) and Haslanger (2012, 381–405).

³⁵ Actually, I am using ‘meaning’ in a more ordinary sense than Perry in order to minimize confusion. For Perry (2001, 17), *meanings* are the rules in a language that assign official content to types of statements.

'94027 is the wealthiest postal district in the US' are true, all one needs to know about '94027' is that it designates Atherton.

Notice that both of the semantic objections I've discussed—the discreteness objection and the visibility objection—presuppose that 'race' has a descriptive meaning in its ordinary use in the contemporary US. If the latter were not an assumption, philosophers would have seen no problem with fuzzy racial membership or races that are not visibly distinctive. Also, the descriptive meaning assumption is present on both sides of the debate. For instance, [Hardimon \(2003, 2013\)](#) is clearly assuming that 'race' has a descriptive meaning in his populationist concept of race.

While I do not think that there is anything wrong in principle with descriptive meanings—however, see [Haslanger \(2012, 429–433\)](#) for a different opinion—I do think that there is something wrong with presupposing that an ordinary meaning of 'race' is descriptive without any empirical support.

The fact is that every attempt so far to find a descriptive meaning of 'race' that an overwhelming majority of ordinary Americans share has eluded social scientists. For instance, in [Glasgow et al.'s \(2009\)](#) study of the extent to which US adults use five commonly discussed identifying conditions for 'race' in the race theory literature, they find that the most frequently used condition is ancestry. However, while [Glasgow et al.'s \(2009, 24–25\)](#) subjects used ancestry 64.5% of the time to classify others into racial groups, 35.5% of the time they did not. [Morning \(2011\)](#) found similarly messy results in her survey of US college students.

When asked to define 'race', the most frequently used identifying conditions were cultural, which were used by 69% of the subjects ([Morning, 2011, 175](#)). However, be that as it may, 31% of the subjects did not reference culture at all when defining 'race'. Furthermore, in the USCB's recent Alternative Questionnaire Experiment, they recruited a nationally representative sample of 768 US adults (including Puerto Ricans) who participated in 67 carefully designed focus groups about race and ethnicity. It is the largest empirical study to date on how Americans think about race. But the result was the same. Americans displayed widespread disagreement about the definition of 'race' ([Compton, Bentley, Ennis, & Rastogi, 2013, 70–71](#)).

Despite these empirical results, some philosophers of race, such as [Glasgow \(2009, 75\)](#), are hopeful that 'race' has a "very thin" descriptive meaning among ordinary Americans. While the latter is possible, it is more productive at this point to explore alternative ways of modeling the US meaning of 'race'. In particular, we should join Sally [Haslanger \(2012\)](#) in exploring referential models of the US meaning of 'race'.³⁶

4.3. Question metaphysical assumptions from the viewpoint of empirically successful biology

A final suggestion I have for moving forward is that philosophers of race should continue to critique these new biological racial realisms on metaphysical grounds, but not by requiring biologically real races to be very important in biology or objectively real. Rather, as long as a biological theory of race is centered on the relevant meaning of 'race' (e.g. the US meaning of 'race'), the entirety of our metaphysical focus should be on whether the proposed racial division is *biologically real* according to a notion of biological reality that "does the most justice" to the "epistemically important" entities in empirically successful biology ([Spencer, 2012, 194, 202](#)).

If we require more from biological racial realism than a defense of race (in the relevant sense) as biologically real, then we will be

requiring biologically real races to be more important to biology than other entities acknowledged as biologically real—such as the "biologically legitimate subpopulations" in "nonhuman species" that are neither subspecies nor clades ([Kaplan & Winther, 2014, 1046–1047](#))—or we will be rejecting the context-sensitive nature of 'race' meanings. However, contemporary philosophy of language regards all word meanings to be context-sensitive, and requiring biologically real races to be more important to biology than other biologically real entities is metaphysically arbitrary.

Furthermore, if we do not require biologically real races to be epistemically important in empirically successful biology, then we will be adopting a biological racial realism that is out-of-touch with contemporary biological practice. For instance, by requiring biologically real races to be objectively real, we will be demoting entities that are uncontroversial examples of biologically real entities to biologically unreal entities, such as the local populations of humans studied in population genetics. However, that's dangerous metaphysics. There is no good reason to think that philosophers have a better grasp of which things are biologically real than practicing biologists. Rather, we should heed [Roberta Millstein's \(2010, 63–64\)](#) advice when she says, "the best work in the field [of philosophy of biology] has been done by those whose work pays careful attention to historical and contemporary biological practice."

Moreover, there is no need to worry that the interpretation of 'biological racial realism' I am offering "waters down" biological racial realism to the point where biological racial anti-realism has no adherents. There will be plenty of philosophers who disagree that race is biologically real in the deflated sense of *race*, in the *relevant meaning of 'race'*, is epistemically important in empirically successful biology. For instance, [Glasgow \(2009, 82\)](#) and [Haslanger \(2012, 300–302\)](#) both reject the claim that US race must be objectively real in order to be biologically real, and both reject the claim that US race must be very important to biology in order to be biologically real. Yet [Haslanger \(2012, 307\)](#) still says, "What "we" in public discourse call race is not a natural or genetic category." And [Glasgow \(2009, 96\)](#) still says, "... populationism will almost certainly fail, so long as it cannot find a coherent biological basis for saying that Latinos constitute a race."³⁷

Finally, if we turn our metaphysical focus to a notion of biological racial realism that has been deflated in the ways that I have suggested, then we can see that there is a particularly promising metaphysical critique of these new biological racial realisms that has been underappreciated. After scanning the various new biological racial realisms, [Roberta Millstein \(2015, p. 5–6\)](#) notices a pattern. In her words, "The authors cited above do not generally specify what they mean by "population"" ([Millstein, 2015, p. 6](#)). Furthermore, [Millstein \(2015, p. 9\)](#) sees this as a problem because it is far from clear that human genetic clusters form real biological populations.³⁸ This is a genuine metaphysical problem for the new biological racial realisms—such as [Risch et al. \(2002\)](#), [Burchard et al. \(2003\)](#), and [Spencer \(2014\)](#).

5. Summary

The main goal of this paper was to present and critique four major semantic and metaphysical objections that philosophers of race have had to biological racial realisms based on recent human

³⁷ [Glasgow \(2009, 4\)](#) defines "populationism" as the view that "races are breeding populations or clusters of breeding populations."

³⁸ In fact, [Millstein \(2015, p. 9\)](#) argues unambiguously for continent-level human genetic clusters *not* being populations, at least according to her causal-interactionist conception of a biological population.

³⁶ See [Haslanger \(2012, 298–310\)](#) and [Spencer \(2014\)](#) for examples of referential US race theories.

population structure research in population genetics. I began by summarizing the population-genetic research that has reignited debates about the biological reality of race. Next, I explored objections that I called ‘the discreteness objection’, ‘the visibility objection’, ‘the very important objection’, and ‘the objectively real objection’. I argued that all of these objections rest on implausible philosophical assumptions about the US meaning of ‘race’ or what ‘biological racial realism’ should mean. I finished by offering constructive suggestions for how to productively critique these new biological racialisms. I recommended that philosophers of race be more critical about the metasemantic assumption that personal intuitions are reliable semantic evidence, the semantic assumption that ‘race’ has a descriptive meaning in the contemporary US, and the metaphysical assumption that human genetic clusters form real biological populations.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at doi:10.1016/j.shpsc.2015.04.003.

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