Individual Variation in Students' Mind-body Ontologies, An Explorative Study

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Abstract

This paper reports on work in progress on student conceptions regarding the relation of the mind and matter. Explorative methods of data analysis and visualization were applied to uncover patterns of variation in student conceptions at the upper secondary and university undergraduate level. Our finding is that there is variety in commonsense ontological commitments and conceptualizations regarding the mind and the body going beyond the traditional division between materialistic and dualistic ontologies. We suggest that the variety is partially based on the fact that – at least when viewed from the perspective of a well-defined scientific or philosophical theory – many commonsense intuitions are not conceptually very well organized.

Keywords: Philosophical intuitions; higher education.

Introduction

In the 1640s, René Descartes claimed that one would continue to exist, even if it turned out that one's sensory experience was an illusion created by an evil deity. Cogito ergo sum. My thinking is ontologically sufficient for my existence. What follows from this, for Descartes, is that the mind and the physical body are genuinely different. Our bodies are entities distinct from ourselves. We can doubt the existence of our bodies, but we cannot doubt the existence of our selves, and we can without logical contradiction imagine ourselves to exist without our body existing, and vice versa.

It has been claimed that people are common-sense Cartesian dualists (Bloom, 2004). It has been also argued that "people universally think of human consciousness as separate from the physical realm" (Bloom, 2006, p.211) and how "Just about everyone believes, for instance, that when our bodies die, we will survive – perhaps going to heaven, entering another body, or coming to occupy some spirit world" (Bloom, 2006, p.211).

On the other hand, "just about everybody" does *not* include most scientist or philosophers of today. It *used to* include just about everybody, even among the scientific community right up to the beginning of twentieth century, after which materialism has become the dominant or "culturally accepted" philosophical and scientific ontology.

When students enter university education in philosophy and cognitive science, they already hold (more or less deeply) views about the mind and its place in nature. Students at all levels (primary, secondary and tertiary) spontaneously develop their own philosophical theories and conceptions about the world, including metaphysical and ontological intuitions about the nature of mind (Stanovich, 1989). Characterization of the variation in this cognitive ecology landscape, which the scientific ideas must find their niche in, is of both practical and theoretical interest.

We are interested in the naturally occurring *variation* in student conceptions, not just whether their world view can be categorized as "materialist" or "dualist". One ought to study these ontological beliefs of lay people in a way that is loyal to their own, in our experience sometimes quite original, ontological conceptualizations. An important methodological upshot from this is that the ontologies students may choose from should not be wholly defined *a priori* or based on an analysis of the content matter to be acquired – e.g. scales and a typology based on the various philosophical theories discussed in current academic philosophy of mind. Instead they should be allowed to emerge from the data itself. The student conceptions should be represented and compared on their own terms. For this purpose, we used combined explorative quantitative and qualitative methods, based on a geometric representation of the students in a "conceptual space" based on their responses.

Combining hierarchical cluster analysis and Self-organizing maps

The self -organizing map (Kohonen, 1999; Vesanto et al., 2000) is an artificial neural network that uses an unsupervised learning algorithm to represent multidimensional data using a small number of elements (nodes or prototypes). Since no *a priori* classification of the input is required to train the map, the method is useful for exploratory data mining and visualization. This is in line

with the ideal of letting the pattern of student similarities and differences emerge from the data, rather than basing them on a prior analysis of content. On the other hand, the map, by itself, assigns no interpretation or categorization to the vectors. In our design, the students' answers were coded into vectors that were clustered with hierarchical cluster analysis. When the response patterns were projected into two dimensions, with similar response profiles grouped together, categorizations provided by the clustering were used to label the responses.

We then went on to analyze the content of the answers of the students to identify patterns and the logical relationships between the categories.

Aims of the Study

A questionnaire was developed to investigate the students' thinking on the relationship between mind and matter. The questionnaire contained several sets of questions probing the ontological conceptions the students held. The first set was used to categorize the students based on their ontological commitment to an immaterial/immortal mind and the dualistic/materialist differentiation of the students with respect to ontology.

Do dualists and materialists disagree on the matter of fact concerning a *shared* ontology of mind and matter? I.e. do they agree what material and immaterial things are, but disagree on whether the mind is an immaterial thing – or might there be consistent differences in the way students with different ontological outlook construe the very notion of matter? The aim of another set of questions was to reveal something about the differential sets of attributes that are related to the mental and the material in the conceptual organization of students' beliefs. To this end, students were asked to identify from a list (Table 4) the properties and attributes that they considered each of the eight categories given in Table 3 to possess. The attributes included (i) physical attributes pertaining to basic mechanics (location, motion, time) (ii) perceptible qualities physical attributes (color, hotness), and (iii) more abstract attributes such as being subject to laws of nature. The categories included the abstract categories of matter and immaterial, the mind, the color red, and four material categories roughly relating to the classical four elements. In what follows we will focus only on analysis of the (im)material status of the mind.

Methods

A multiple choice questionnaire containing items pertaining to the mind-body problem was administered to upper secondary and university undergraduate students. The students were classified into groups based on a set of diagnostic questions using hierarchical cluster analysis, and the groups were visualized with a Self-Organizing Map (SOM). The classification was interpreted qualitatively to reflect different ontological stances of the students.

Subjects

All in all 181 students completed the questionnaire (121 upper secondary students and 60 university students). Eleven university students were excluded because of having already completed a university degree (MA, MSc.), leaving a sample of 170 students (121 upper secondary students, 49 university undergraduates, mean age 19±4 years).

The upper secondary students (65 male, 56 female) were students of a large upper secondary school in the area of Helsinki and two upper secondary schools of Oulu (in northern Finland). The mean age of the upper secondary students was17±1 years. The students were of variable socio-economic background and academic ability. The university students (34 male, 15 female) were enrolled on introductory courses in philosophy of mind and cognitive science, and filled the questionnaire in partial fulfilment of course requirement. The mean age was 24±5, and the students came from a variety of disciplines (Table 1).

Table 1: University students by major subject.

Major subject	students
Philosophy	13
Cognitive Science	9
Language & humanities	7
Mathematics	6
Computer Science	5
Other	9
Total	49

Materials & procedure

A paper and pencil questionnaire was administered in class. All responses were given anonymously and the students were told that there were no "right" answers to the questions and that they would not be graded on their answers. The students were allowed to complete the questionnaire at their own pace.

The set contained 16 statements (Table 2) and the students answered on a seven-scale likert scale whether they were in agreement or disagreement with the statement ("definitely true" to "definitely untrue"). The questions were framed as much as possible "in the students' own language", that is, using somewhat loose commonsense turns of phrase, rather than precise definitions and qualifications of academic philosophy.

Another set (8 questions, with 20 yes/no items each) was designed to further probe the way the students related different attributes to mind and matter, and how they conceived mind and matter to other categories of entities, such as air or colors (see Table). The students' task was to judge whether, in their opinion, each of the categories was material or immaterial (a seven point scale was used), and whether they possessed or did not possess one of the twenty attributes listed in Table 4. The students also completed a two other sets of questions pertaining to mind-body interaction and reincarnation beliefs. These data are not analyzed nor further discussed here.

Data-analysis & Visualization

A hierarchical cluster analysis of the responses to the diagnostic questions (squared euclidean metric, Ward's agglomeration method, performed using SPSS 15.0). The clustering solution suggested that the students could be classified into three fairly homogeneous groups. The purpose of the cluster analysis was to provide *category labels* for the students, so that the overall pattern of student conceptions in the "conceptual space" of our respondents could be readily identified in the SOM maps.

The SOM maps were constructed and visualized using SOM Toolbox (version 2) for Matlab (Vesanto et al., 2000). The SOM map consists of neurons organized in a hexagonal grid. For visualization of the answers to q1-q16, each neuron is represented by a 16-dimensional weight vector (one component per question).

The distance between neighboring neurons is measured by calculating the Euclidean distance between the weight vectors. The structure of the map can then be visualized by assigning color codes to the distance measures. E.g. neighboring neurons that are very dissimilar in the Euclidean sense would be separated by dark "walls", while patches of similar neurons are identified by light "islands" on the map.

Table 2: The ontological commitments probe questions used to cluster the students.

no.	Question
q1	Material entities can bring about (cause) changes in material entities.
q2	*Only* material entities can bring about (cause) changes in material entities.
q3	The human mind has a material basis.
q4	The human mind has no material basis.
q5	The human mind has a material basis in brain activity, without which it can not exist.
q6	When a human being dies, his/her mind no longer exists afterwards.
q7	When a human being dies, his/her mind can still exist afterwards.
q8	The human body can sometimes exist without a human mind.
q9	The human mind can sometimes exist without a human body.
q10	The human body can never exist without a human mind.
q11	The human mind can never exist without a human body.
q12	The human mind can bring about (cause) changes in the human body.
q13	The human body is: matter … immaterial
q14	The human body is: a material entity … an immaterial entity
q15	The human mind is: matter … immaterial
q16	The human mind is: a material entity … an immaterial entity

At first, the orientations of the vectors are random. The SOM is then trained as follows. The subjects' responses to the 16 diagnostic questions can themselves be considered as 16-dimensional data vectors, each vector representing one subject's responses. The data is first normalized to avoid any one dimension becoming dominant. In each round of training one samples a data vector at random, finds the best matching neuron on the SOM and then modifies the neuron and its neighbors slightly so that they match better to the training sample. After many rounds of training, the end result is that the neurons on the SOM become ordered: neighboring neurons have similar weight vectors. The subjects are then associated to the best matching map nodes and one obtains a map where subjects with similar response profiles are close to each other while different types are farther away or separated from one another.

Table 3: The categories.

c1	Matter
c2	Something immaterial
c3	The human mind
c4	The color red
c5	Water
c6	The flame of a candle
c7	Air
c8	Sand

Table 4: The attributes.

a1	Always has a location
a2	Always has a size
a3	Always has a shape
a4	Always has weight
a5	Has a beginning and an end in time
a6	Is timeless
a7	Can only exist if matter exists
a8	Can move from one place to another
a9	Can move a definite distance
a10	Can move a distance which can be measured
a11	Can move from one place to another during a definite period of time
a12	Can move from one place to another at a definite speed
a13	Can move from one place to another at a speed that can be measured
a14	Is subject to laws of nature
a15	Can bring about (cause) changes in material entities
a16	Can change from one form * to another
a17	Can be colored
a18	Can be hot or cold
a19	Can form compounds with other substances
a20	Always has structure

* The word for form is the Finnish word used to distinguish different phases of substances (solid, liquid, gas) from one another.

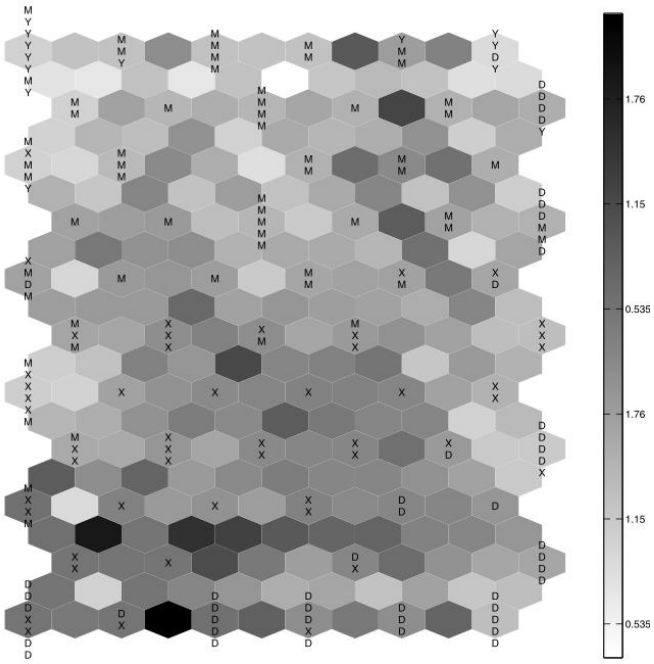

Fig. 1 The map is based on the proximity of response patterns on questions probing ontological commitments. Darker hex indicates longer distance between units in the input vector space. Students' ontological categorization labels plotted on map. Materialists (labels *M* and *Y*) are found in the upper left corner, dualists (*D*) at the lower right. Group *X* is more scattered, and located roughly in between the two opposites.

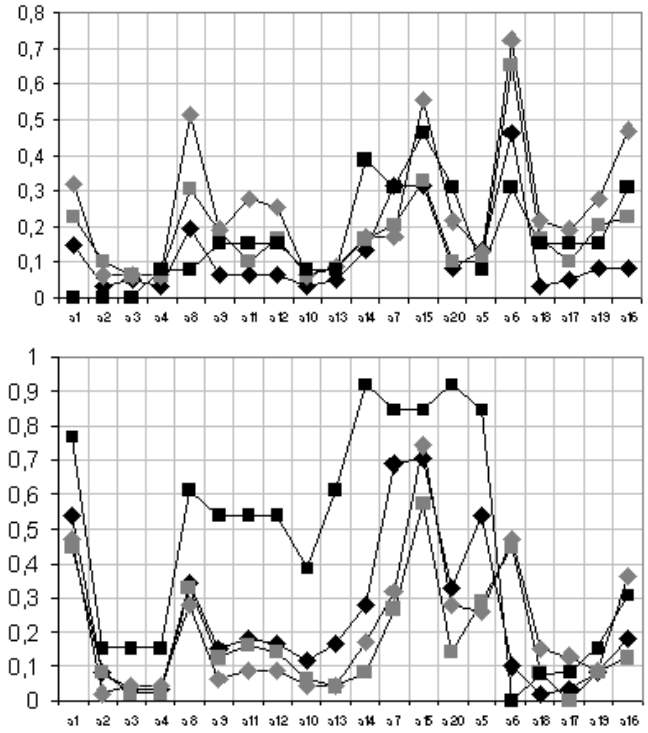

Fig. 2 Attributes assigned to the immaterial (top) and the mind (bottom) by the different groups. (x-axis: attributes; y-axis: fraction of students in the group who assigned the attribute to the category). *D* = gray diamonds; *M* = black diamonds; *X* = gray squares; *Y* = black squares.

Visualization of the trained SOM map is seen in Fig. 1. The map consists of 11x6 neurons (the hexes with letters in them), separated by cells representing the distance measures. The students are plotted on the map in the appropriate cells. For purposes of reproduction and readability, only the category label of the subject given by the cluster analysis (*D*, *M*, *Y*, *X*) is shown for each subject. This is sufficient to get an overall view of the similarity organization of the responses.

Results

The first set of items (Table 2) probed the basic ontological commitments of the students. Cronbach's alpha for this scale of items was 0.807. When the different response patterns of the groups - identified by the cluster analysis - were qualitatively interpreted, we could assign an ontological interpretation to the group differences. The largest cluster we could readily interpret to be *materialists*, comprising nearly half of our sample (74 students). These students affirmed a material basis for the mind (q3-q5), and denied the mind would or could continue its existence after death (q6, q7, q9, q11). The other half were divided into the fairly homogeneous cluster of *dualists* (47 students), and another group who were "between materialism and dualism", and whom we will refer to as group *X* (49 students). An overview of the patterns of responses can be quickly formed by looking at Figure 1: The materialists are a homogeneous group, except for a small cluster (13 students) whom we chose to give a separate label on the maps (*Y*). These students were the furthest away from the dualists seemed to have a somewhat different conception of materialism from the rest (see discussion, below). The average responses of the groups to each of the questions can be found in Tables 7 and 8 (scoring "definitely true" as 3 and "definitely untrue" as -3, undecided as 0).

A main line of demarcation appeared to be the belief in a mind that would or could continue to exist after one's body has perished (questions 6, 7, 9 and 11), and to a slightly lesser extent the belief in the material basis for the mind (questions 3-5). Overall, the dualists affirmed the existence of a mind that could survive the death of the body, while the other groups tended to deny this. (Although there was individual variation and a large percentage of non-committed middle of the scale answers, especially in group *X*). Another line of demarcation would seem to separate group *X* from the materialists (especially the *Y* variety) and, to a lesser extent, the dualists.

A Principal Components Analysis showed that the there was one (rotated) principal component that separated the materialists and the dualists, and a second and third component that differentiated group *X* from *Y* (Tables 5 & 6)[1]. The three components accounted for half (51%) of the variance in the responses.

On the items related to attributes associated with the mental and the material, group *Y* also differed from the rest (see Fig. 2). Overall, we found that the average response profiles for the category *Matter* across the physical attributes (a1-a4) and the concrete attributes (a16-a19) were very similar across all groups (group *Y* assigning marginally more, group *X* slightly less of the physical attributes). It is the view on the mind and the immaterial which differentiates between them. Specifically, the properties assigned to the category *Immaterial* were largely similar for the groups (except that the dualists and the *X*:s assigned movement, a8, and timelessness, a6, to the mind). However, when it came to mind, the students in group *Y* were clearly different, as can be seen from Fig. 2. They seem to have a much more "physical" view of the mental: with the items related to motion (a9-a13) this group (but not the others) assigns the to the mind (but not the immaterial). This group also considered the mind (but again not the *immaterial*) to be subject to the laws of nature (a14) – most of the other students, including materialists, did not.

Discussion

Many of the respondents in our study seemed to be advocates of an ontology that can be considered "materialistic" in some sense in that they consider the mind to be ontologically dependent on the body. On the other hand, it seems the mind itself is still considered, by our "materialistically inclined" students, in quite dualistic terms (that group *M* are not "epiphenomenalists" can be seen from the fact that they predominantly considered the mind to be able to cause changes in the body, q12). So while the "materialists" believe in a material *basis* and mortality of the mind, many still have a conception of the mind itself very much like the dualists.

A notable exception is the *Y* subgroup among the materialists. This subgroup was most strongly of the opinion that the human mind is material (q15 & q16). Among the materialists, the opinion was divided – most chose a non-committed answer in the middle of the scale, with an equal number affirming and denying the proposition. (In contrast, the dualists, as well as group *X*, were quite strongly in favor of the mind being *im*material). However, like many materialists group *Y* denied that the mind would survive perishing of the body, but they also *differed* from the other materialists and resembled dualists in that they also denied that a human mind could not exist without a human body.

[1] We also performed a Multidimensional Scaling which does not require an interval measurement scale, and makes less stringent assumptions about distributions. It produced the same overall result of one dimension differentiating materialists from dualists and another differentiating *X* from the rest, but especially from *Y*.

Table 5: Correlations of the item scores to three varimax rotated principal components.

no.	1	2	3
q1	-0.10	0.20	**0.55**
q2	0.13	0.22	0.11
q3	0.15	**0.73**	0.41
q4	0.08	**0.69**	0.32
q5	0.22	0.24	**0.62**
q6	**0.84**	0.26	0.07
q7	**0.86**	0.20	0.04
q8	0.08	0.06	0.08
q9	**0.85**	0.03	0.10
q10	0.02	0.08	0.09
q11	**0.81**	0.03	0.10
q12	0.09	0.10	0.16
q13	0.13	0.00	**0.86**
q14	0.03	0.02	**0.79**
q15	0.11	**0.86**	0.00
q16	0.14	**0.82**	0.10

Table 6: Individual responses mean regression to the components, by group.

no.	1	2	3
D	**-1.22**	-0.33	-0.07
M	**0.65**	0.39	0.33
Y	-0.37	**1.41**	**0.37**
X	0.45	**-0.55**	**-0.45**

Table 7: Group mean responses to the ontological questions 1-12 (-3 indicates a negative answer, and 3 indicates a positive answer on a seven-point scale).

question	D	M	Y	X
q1	2.2	2.5	2.7	1.4
q2	-2	0	0	-1
q3	0	1.7	2.9	0
q4	0	-2	-3	0
q5	0.9	2.2	2.4	0.6
q6	-1	1.8	2.5	1.6
q7	1.6	-2	-2	-2
q8	1	2.3	2.8	0.8
q9	1.8	-2	1	-1
q10	-1	-2	-3	-1
q11	-2	1.8	-2	0.6
q12	2.3	2.5	2.6	1.8

Table 8: Group mean responses to the ontological questions 13-16 (3 indicates a "material" response -3 an "immaterial" response on a seven-point scale).

question	D	M	Y	X
q13	2	3	3	2
q14	2	3	3	2
q15	-1.7	0	2	-1.7
q16	-1.6	0	1	-1.3

What could be behind this apparent contradiction? Are these students just confused? We think not. The group comprises mainly of Cognitive Science, Computer Science and linguistics/humanities students (one upper secondary student). *Y* thus represents precisely the subgroup that would be expected to be the most strongly exposed to alternative, counterintuitive materialist ontologies (e.g. the computational theory of mind and multiple realizability). These students might therefore think the mind cannot exist without a material basis, but that this material basis need not be the brain (maybe the mind can be downloaded on a computer etc.). This interpretation is given some corroboration by looking at the group level responses to the questions about the material basis of the mind (Tables 7 & 8). Group *Y* has by far the highest mean value in response to the statement q4 "The human mind has a material basis" (mean 2.9). By comparison mean for *M* is 1.6, for *X* it is -0.3 and for *D* -0.1. However, response to the statement q5 "The human mind has a material basis in brain activity, without which it cannot exist" is 2.4 – i.e. *less* - while for all other groups q5 has a *higher* mean than q3. In other words, our most materialistic students were less inclined consider mentioning the brain as the basis of the mind as important.

The opposite is true for the dualistically inclined – indeed, 14 members of groups *D* and *X* first denied that the mind has a material basis, giving a negative answer to q3, and then immediately affirmed that brain activity is a material basis of the mind!

This is an important finding in another sense: it brings home the subtlety of assigning interpretations to student responses. Interpreting answers to individual items at face value as indicative of either materialist or dualist ontology, e.g. taking higher scores on q5 to indicate "more materialistic" and lower scores "less materialistic", misses out on important pattern. The responses should be looked at in the context of responses to other questions (here the comparison between q3 and q5).

Conclusions & Future directions

In this paper we have presented work in progress on secondary and undergraduate students' conceptions regarding the relation of the mind and matter. Explorative data analysis and visualization methods were applied to uncover patterns of variation in student conceptions.

At least among our Finnish respondents it appears not "just about everybody" is committed to dualist ontology. On the contrary, there is a rich variety in common sense ontological commitments and conceptualizations regarding the mind and the body.

Many of the respondents in our study seemed to be advocates of an ontology that can be considered "materialistic" in some sense in that they consider the mind to be ontologically dependent on the body. On the other hand, it seems the mind itself is still considered, by our "materialistically inclined" students, in quite dualistic terms. This suggests that the students' intuitive conceptions may not form well-differentiated and internally coherent conceptual clusters, but that there is

We found one subgroup among the materialists, who had a much more "physical" view of the mind. This group also considered the mind to be subject to the laws of nature – (most of the other students, including materialists, did not!). However, while group *Y* denied that the mind would continue to exist after death, they also differed from the other materialists (and resembled) dualists in that they *also denied* that a human mind could not exist without a human body. Thus, they were on the one hand "between materialists and dualists" (on the first principal component axis), but very differently so from the *X* students. One may speculate that these students base their response on some kind of "functionalist" framework that allows other material substrates beside the brain, possibly due to exposure to such ideas in the philosophy of mind and cognitive science. We hope to further clarify the thinking behind different patterns of answers by interviewing students with response profiles most characteristic of each group. Are the Y students responding based on some kind of proto-functionalism? Are the 14 members of *X* and *D* alluded to above simply undisturbed by their own lack of coherence, or is there an underlying logic to their answers?

Also, are there systematic differences among university students of different disciplines? How does higher education in, say, neuroscience, philosophy, psychology or computer science affect one's view on the relationship between the mind and the body? The small sample size of our study does not allow us to address these questions quantitatively, and will be left to future study.

Pursuing such questions emerging from our data will hopefully help us elucidate the full pattern of variation in student conceptions, and help in designing more adequate quantitative measures to capture all the dimensions that characterize individual differences in students' ontological conceptions.

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