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TEACHERS' CONCEPTIONS OF BIOLOGICAL DETERMINISM IN FIVE COUNTRIES: DENMARK, ESTONIA, FINLAND, FRANCE AND ITALY

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In collaboration, for gathering the data, with *Anna Liisa Kosonen*, *Adriana Valente* and their groups in University of Joensuu (Finland) and C.N.R., Rome (Italy)

Abstract: The interaction between the genome and its environment (epigenetics) is a new paradigm in biology. Nevertheless, the notion of genetic determinism is still present in syllabuses and textbooks. What about teachers' conceptions?

We analyzed the teachers' conceptions related to the genetic determinism of human performances in five European countries, using 24 questions of the Biohead-Citizen questionnaire.

The conceptions of the 2038 teachers, when grouped by country, show clear and significant differences, being more deterministic in the three countries of North Europe (Finland, Estonia, Denmark) than in Italy and France, and more sexist for only some of the related questions.

When grouped by religion, the differences are significant but disappear after suppression of the country effect, while this last one does not disappear after suppression of the religion effect: there is no specific religion effect. There is a gender effect (female teachers being more feminist), an effect of the level of instruction at University (the most instructed teachers having more knowledge but also some more tolerant attitudes), and an effect of age (the oldest believing more in genetic determinism).

A Co-Inertia analysis shows significant correlations between teachers' answers on genetic determinism with their political opinions: genetic determinism (as belief of heredity of intelligence) and intolerant attitudes (as sexism and racism) are correlated with the most conservative political opinions.

Finally, we found a specific and paradoxical effect of biology training of teachers: biologist teachers have, without surprise, more knowledge than their colleagues, but are also more convinced of the importance of genetic determinism: their training in biology still needs to be improved by introducing the most recent concepts of genetics, as epigenetics.

Keywords: Genetic determinism, Epigenetics, Teachers' conceptions, International comparisons, Gender.

THEORETICAL BACKGROUND

The debate between nature and nurture is outdated, both being necessarily in constant interaction (Jacquard, 1972; Atlan, 1999; Lewontin, 2000; etc.). The interaction between the genome and its environment (called "Epigenetics": Wu & Morris, 2001) is a new paradigm in biology. Nevertheless the syllabuses and school textbooks are just starting to change (Castéra et al, 2008; Clément & Castéra, 2013; Gericke et al, 2012). What about the teachers' conceptions?

Outdated knowledge can be used to justify a pre-determinism of individual performances (intelligence, music, ...) or of social intolerant attitudes as sexism or racism (Keller, 2005).

A previous communication (Castéra & Clément, 2009a) showed that more Finnish than French teachers were convinced of a genetic determinism. In consequence, we decided to extend this comparison to more countries in North and South of Europe.

Our general theoretical background is the KVP model (Clément, 2006, 2010), analyzing the conceptions as possible interaction between scientific knowledge (K), values (V) and social practices (P). A comparison between countries differing by their socio-cultural contexts can help to identify the difficulties of some teachers to change their conceptions after a renewal of the scientific knowledge, as it is the case by the emergence of epigenetics in biology.

This new paradigm is concerning all the teachers, not only biology teachers, because the way of teaching is not the same when you consider students' performances as genetically determined (innatism) or when you know that the genetic characteristics of any person is strongly interacting with their environment along their singular history (epigenetics).

RESEARCH QUESTIONS

We wish to compare teachers' conceptions of biological determinism of human performances in five European countries. Do they differ among countries, or among groups of countries? Three of them are in Northern Europe, the two others in Southern Europe. Moreover, the results of PISA before our research (2006) showed that Finland obtained the best score on the scale of the "*scientific literacy*" while France and Denmark obtained a score just under the OECD average, and Italy a lower score.

When teachers were trained in biology (teaching biology, or teaching in primary schools after a training in biology: we call them "biologist teachers"), do their conceptions differ from those of their non-biologist colleagues?

Teachers' religions differ among these countries (Table 1): is there a religion effect independent to the country effect?

Do the teachers' conceptions vary with other controlled parameters, independently to their nationality, as gender, age, level of instruction, political opinions?

METHODOLOGY

Our sampling (Table 1) comes from five countries, three in Northern Europe, two in Southern Europe. In each country, the questionnaire was completed by a balance of in-service teachers (i.e. currently active) and pre-service teachers (i.e. adults in their last year of teacher training). Six categories of samples were defined: in-service primary school teachers (inP), in-service secondary school biology teachers (inB), in-service secondary school language teachers (inL), pre-service primary school teachers (preP), pre-service secondary school biology teachers

(preB) and pre-service secondary school language teachers (preL). Each sample was about 50 teachers but only 30 in a small country as Estonia, and more in France and Italy where complementary hypotheses were tested. A total of 2038 teachers completed the questionnaire.

Table 1

Our sampling (Others = no answer + minority religions)

	Country	Total	Including Biologists	% Agnostic	% Catholic	% Protestant	% Others
DK	Denmark	259	111	44,8	1,9	34,4	18,9
EE	Estonia	182	108	43,4	7,7	14,8	34,1
FI	Finland	306	121	15,0	1,0	66,3	17,6
FR	France	732	319	50,5	38,1	1,9	9,4
IT	Italy	559	150	12,3	78,7	0,5	8,4
	Total	2038	809				

The research design and the questionnaire were defined and validated during the BIOHEAD-Citizen project (Clément & Carvalho, 2007; Munoz et al., 2009, Castéra & Clément, 2012). Teachers anonymously answered to a large questionnaire (144 questions) translated in their language (parallel independent translations followed by a retro-translation into English).

Pre-service teachers filled out the questionnaire at the end of a course concerning all a promotion, and the questionnaire was immediately collected to have no bias of sampling. Some in-service teachers also filled out the questionnaire after a course or a meeting, but some others did that inside their school, after being gathered in a group. In each case, the researcher was present, explaining in the beginning that the process is totally anonymous and free, but also that the teachers had to answer to all the questions, because the questionnaires with more than 5% of not filled questions are then withdrawn.

We analyze here the teachers' answers to 24 questions related to genetic determinism. All these questions are reproduced in Castéra & Clément (2012), and the main important of them (those differentiating the most the teachers' conceptions) are reproduced below inside the results. These questions can be grouped into five different categories:

- (1) Genetic determinism of personal or individual features: questions about clones and twins (A3, A6, A19, A24, A43 and A53).
- (2) Genetic predisposition of children' performances (B8, B10, B11, B14, B20)
- (3) Genetic/biological differences related to gender (A2, A9, A14, A21, A25, A30, A36, A38 and A46).
- (4) Genetic differences among ethnic groups (A35) or among social behaviour (B4).
- (5) A more general knowledge of genetics (A27, A31), although recognizing that question A27 can also be influenced by innatism.

We also use here teachers' answers to 17 questions related to their personal characteristics, and to their political or religious opinions.

All the questions are closed, generally with a Likert scale of four boxes.

The data were then analysed with appropriate multivariate analyses (Munoz et al, 2009; Castéra & Clément, 2012), using the software “R”. We also used t-tests with Bonferroni’s correction.

RESULTS AND DISCUSSION

The country effect

A between-class analysis (Fig. 1) clearly opposes Northern to Southern European countries. These differences are very significant ($p < 0.001$: test of randomization).

The questions differentiating the most the five countries are (Fig. 1c):

- The seven questions related to genetic pre-determinism of individual performances: “*There are genetic factors in parents that predispose their children to become: good in school*” (B10, Figure 2), “*very good violinists*” (B20), “*aggressive*” (B14), “*alcoholics*” (B8), “*homosexual*” (B11), and two questions related to similarity of human clones of “*Einstein*” (A3) and “*Mozart*” (A24).
- “*Human social behaviour is partly directed by genes*” (B4).
- Two questions related to a biological justification of gender differences: “*to take care of housekeeping*” (A38, Figure 3); “*to think logically because men might have different brain bilateral symmetry.*” (A36), and two questions related to the gender equality of rights (A30, A2).
- And, with a less weight, the question related to racism: “*Ethnic groups are genetically different and that is why some are superior to others*” (A35) and a question related to knowledge (role of chance for the child’s sex: A31).

For most of these questions, the t-tests with Bonferroni’s correction show significant differences between each pair of countries, with only some exceptions (as between some pairs of Northern countries).

There is no significant difference between countries for five other questions related to a biological justification of sexist gender differences. Globally, in the three Northern countries, the teachers’ conceptions are more in favour of a genetic determinism of human features, behaviours or performances, including to justify some (but not all) sexist or racist propositions.

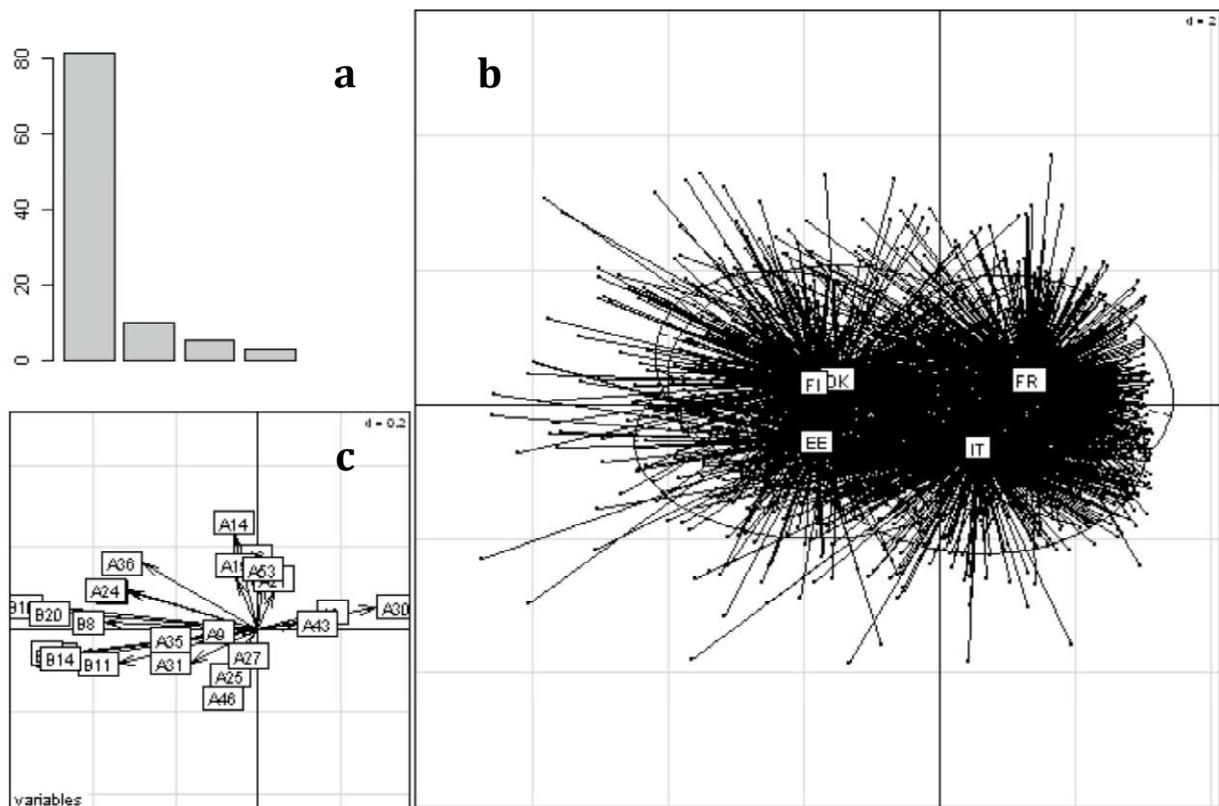


Figure 1. Between-class Analysis differentiating the five countries.

a – The first component expresses more than 80% of the total variance.

b – Each point represents a teacher’s conceptions, and is linked to the centre of gravity of his / her country (FI= Finland; DK=Denmark; EE=Estonia; IT = Italia; FR= France).

c – The answers explaining this difference among countries: see the text for explanations.

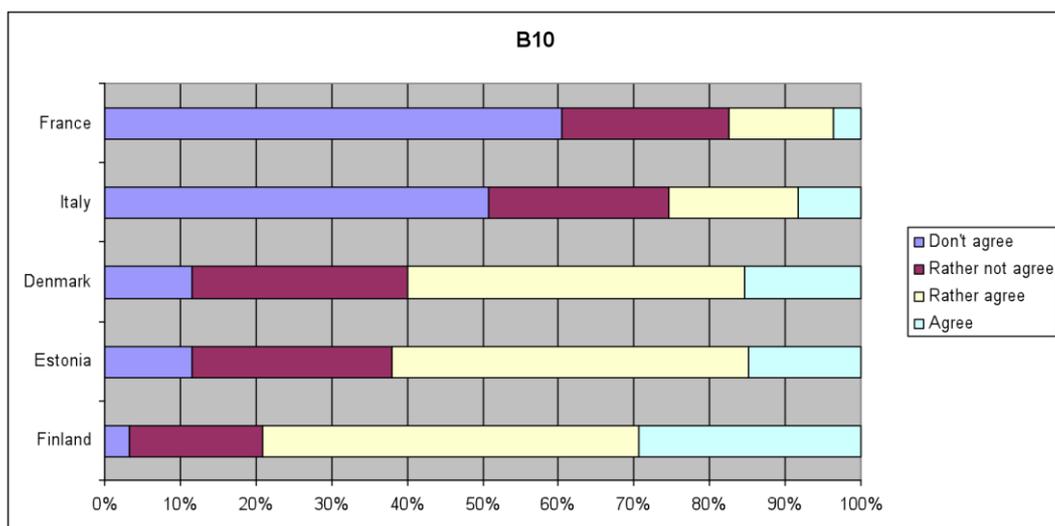


Figure 2. Teachers’ answers (grouped by country) to the question B10:

There are genetic factors in parents that predispose their children to be good in school.	I agree					I don't agree

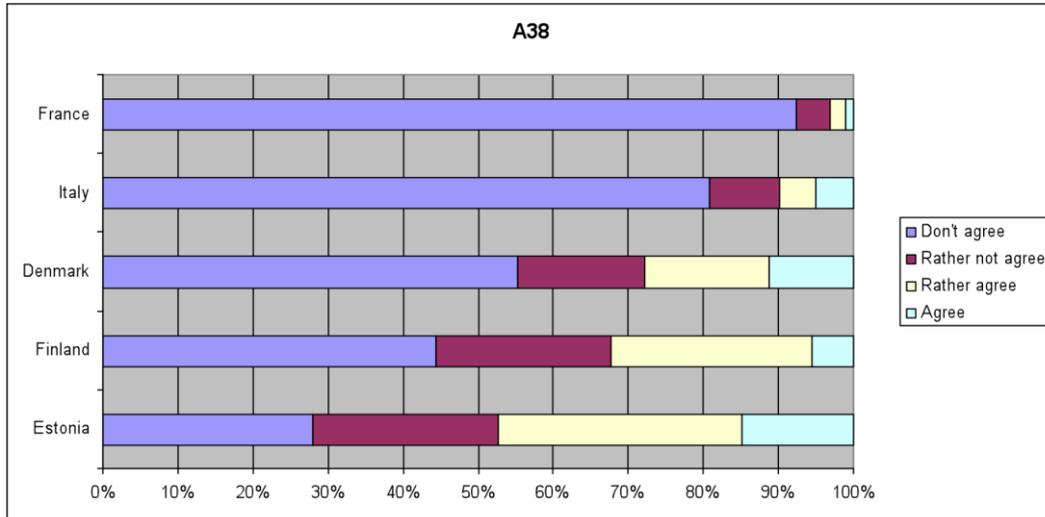


Figure 3. Teachers' answers (grouped by country) to the question A38 :

It is for biological reasons that women more often than men take care of housekeeping.	I agree					I don't agree
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Absence of a specific religion effect

After grouping the 2038 teachers into four groups depending their religion (Table 1), a between-class analysis shows significant difference between the four groups, but this difference disappears after suppression of the country effect, while this country effect does not disappear after suppression of the religion effect.

That means there is no specific religion effect.

A paradoxical effect of training in Biology

A between-class analysis shows a very significant difference between biologist teachers (Table 1) and other teachers, persisting after suppression of the country effect. This difference is paradoxical: biologist teachers have more knowledge than their colleagues, but are also more convinced of a genetic determinism. The figure 4 illustrates this effect for two countries (France and Finland): the great difference between the two countries is the "country effect", described above. Nevertheless, inside each country, there is a significant difference between teachers trained in biology at University (B) and other teachers (NB). That suggests the way biology is taught at University induces more conviction in a genetic determinism, while it is now outdated with the emergence of epigenetics.

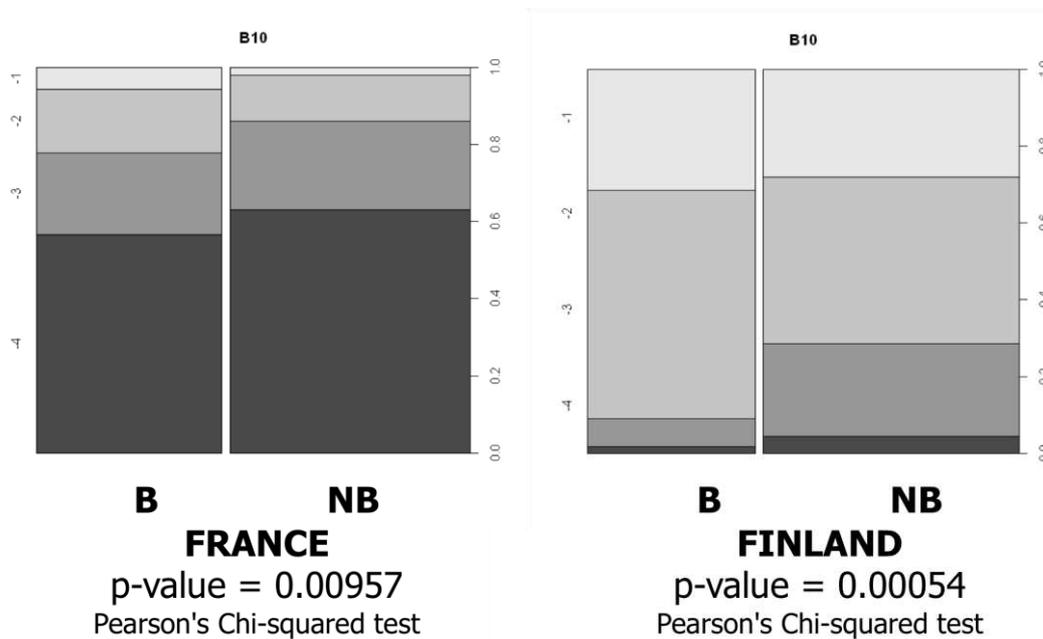


Figure 4. Answering to the question B10 (There are genetic factors in parents that predispose their children to be good in school), the difference between B and NB is significant in France as well as in Finland: Biologist Teachers (B) are more innatist than their Colleagues (NB). The shades of grey correspond with the answers on the Likert scale: Light grey (agree) to dark grey (do not agree)

Other effects

There is a fine gender effect, still significant after suppression of the country effect: female teachers are less sexist (more feminist) than their male colleagues. That is not a surprise: this effect was previously analysed in some of our precedent works (Castéra & Clément, 2009b).

There is also a significant effect of the teachers' level of training at University. The most instructed teachers have more knowledge and often more tolerant attitudes. This effect is very interesting to encourage a longest initial training of teachers at University.

The effect of teachers' age is also significant; it is partly similar to the precedent effect but oldest teachers believe more in genetic determinism. That is probably a consequence of the great prevalence of innatist ideas during the second half of the 20th Century (Atlan, 1999), and a difficulty of oldest teachers to change then their conceptions. It is also interesting to see that the youngest teachers are less influenced by the conceptions related to a dominant influence of the genetic determinism (innatism).

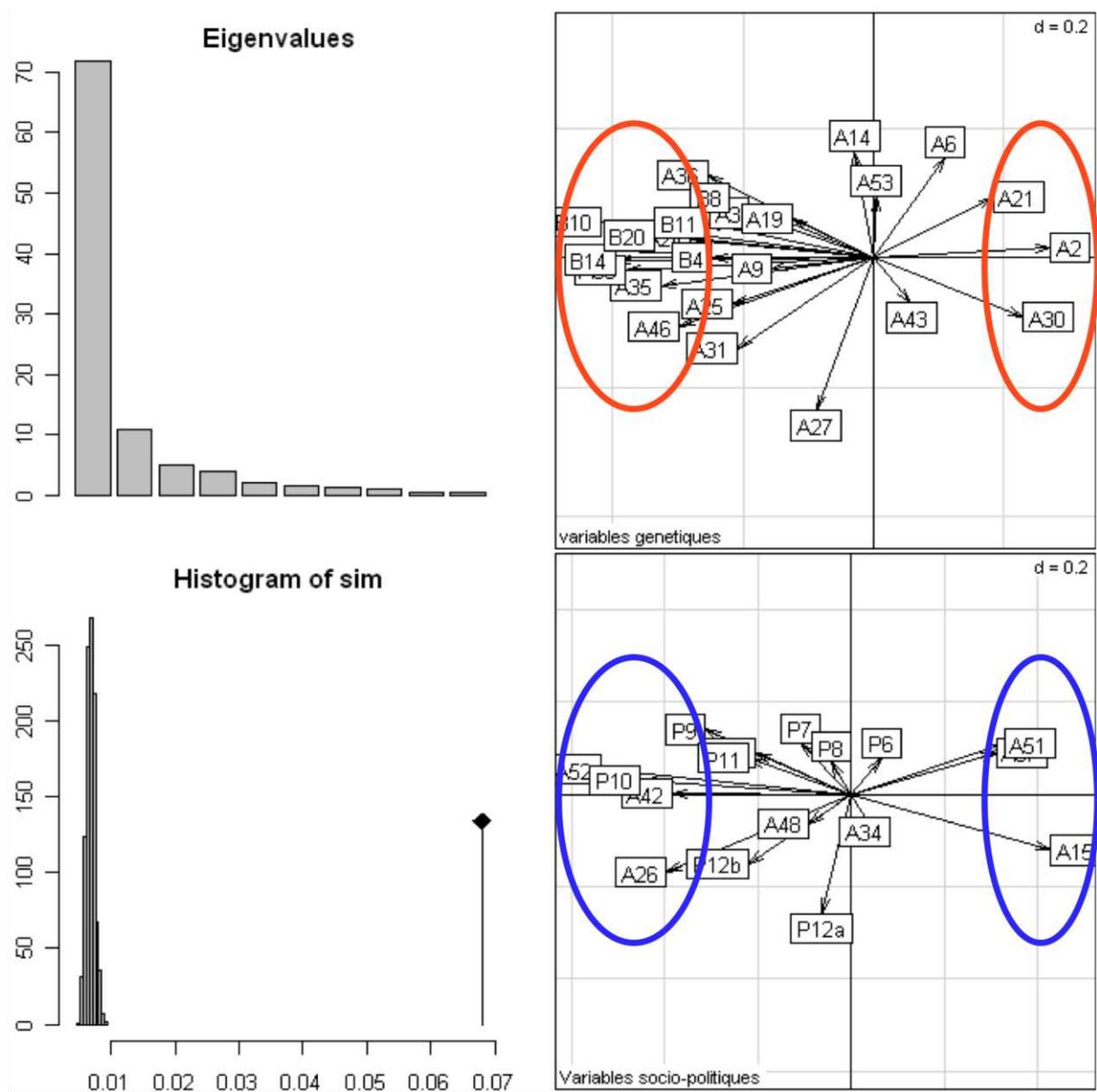


Figure 5. A Co-Inertia analysis shows significant correlations between a PCA from answers related to biological determinism (24 questions – red circles around the questions which more differentiate the teachers) and a PCA from teachers’ socio-political opinions (17 questions - blue circles around the questions which more differentiate the teachers).

The graph “Eigenvalues” shows that the main oppositions inside teachers’ conceptions are related to the component 1 (the horizontal axis).

The graph “Histogram of sim”, coming from the randomization test (Monte Carlo), shows that the observed distribution (the trait on the right) is entirely outside the histogram built from 1000 essays by chance (on the left): the correlation between the two PCA is very significant ($p < 0.001$).

A Co-Inertia analysis (Figure 5) shows significant correlations between two PCA, from answers related to biological determinism (24 questions: B10, B20, B14, A38, A35, ...) and from teachers’ socio-political opinions (17 questions): the belief in genetic determinism is correlated with the most conservative political opinions (e.g. *less access to health care for poor people, too many foreigners in my country, for private health services, for private*

pensions, against the separation between science and religion, and also between religion and politics, ...).

CONCLUSION

Our results show two opposite trends:

- (1) A global link between belief in genetic determinism, intolerant attitudes as sexism or racism and conservative socio-political opinions. And reciprocally, a link between belief / knowledge related to less genetic determinism, and more tolerant attitudes. That is a confirmation of works in social psychology (Dambrun & Taylor 2005, Keller 2005). That is also an illustration of interaction between knowledge, values and social practices (the KVP model).
- (2) Nevertheless, in the three Northern Europe countries, teachers mainly believe into a genetic determinism of human performances, but express sexist views only for some questions. Five of the nine questions related to gender differences show a very little amount of sexism, without any difference between Northern and Southern European countries, showing the same feminist conceptions of the interviewed teachers.

Concerning our initial questions of research, the most important differences among the teachers' conceptions oppose the countries, mainly North to South of Europe. Why these differences is not so easy to explain. The differences are mainly dealing with the questions related to genetic predisposition of children' performances (as illustrated for instance in the figures 2 and 4). A possible interpretation could be that the meaning of "predisposition" is not the same in the Northern languages than in the Latine languages of Italy and France, where it is synonymous to "predestination". Nevertheless, when working in Denmark (three months in Copenhagen for Pierre Clément) or in Estonia (three years in Tartu for Jérémy Castéra), we discussed several times with biology teachers who are really convinced that the human intelligence and other performances are strongly linked to a genetic determinism. While it is not the case in France or Italy, probably as a consequence of historical features of these countries, with more social influence (through medias, conferences, ...) of philosophers or scientists strongly opposed the ideologies as innatism. It would be interesting to document more this hypothesis of socio-cultural difference between Northern and Southern European countries.

These conceptions also vary with other teachers' characteristics: their gender, age, level of training in University. We proposed inside these results some possible explanations. In the perspective of improving science education, important is the paradoxical difference between biologist and other teachers: their biology training seems to be still structured by the notion of genetic determinism, and poorly related to the most recent genetic knowledge. That is possibly easier to change in each of the five countries of our sample, than the deep socio-cultural context of these countries.

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