

MEASURING STUDENTS' TELEOLOGICAL AND ESSENTIALIST CONCEPTIONS IN THE CONTEXT OF GENETICS: A COMPARISON OF EXPLICIT AND IMPLICIT MEASURES

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**UNIVERSITÉ
DE GENÈVE**

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FONDS NATIONAL SUISSE
DE LA RECHERCHE SCIENTIFIQUE

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The public image of genes


The public image of genes

SundayReview | Infidelity Lurks in Your Genes

SundayReview | CONTRIBUTING OP-ED WRITER

Infidelity Lurks in Your Genes

 **Richard A. Friedman** MAY 22, 2015



AMERICANS disapprove of marital infidelity. Ninety-one percent of them find it morally wrong, more than the number that reject polygamy, human cloning or suicide, according to a 2013 Gallup poll.

Yet the number of Americans who actually cheat on their partners is rather substantial: Over the past two decades, the rate of infidelity has been pretty constant at around 21 percent for married men, and between 10 to 15 percent for married women, according to the General Social Survey at the University of Chicago's independent research organization, NORC.

Marion Fayolle

<http://www.nytimes.com/2015/05/24/opinion/sunday/infidelity-lurks-in-your-genes.html?partner=rss&emc=rss>

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Women are more likely to cheat on their partner if they carry the 'infidelity gene', scientists discover

- Scientists have found variations of a gene are linked to 'extrapair mating'
- Variants of 'infidelity gene' make women more likely to cheat on partners
- University of Queensland scientists studied DNA and lives of 7,378 people
- They found variant of gene present in large number of unfaithful women
- Variants of AVPR1A gene only has an impact on women, scientists found



QuantSeq 3' mRNA-Seq - Learn more

<https://www.dailymail.co.uk/sciencetech/article-2954349/Women-likely-cheat-partner-carry-infidelity-gene-scientists-discover.html>

The public image of genes



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News

Lighter sentence for murderer with 'bad genes'

Italian court reduces jail term after tests identify genes linked to violent behaviour.

Emiliano Feresin

An Italian court has cut the sentence given to a convicted murderer by a year because he has genes linked to violent behaviour — the first time that behavioural genetics has affected a sentence passed by a European court. But researchers contacted by *Nature* have questioned whether the decision was based on sound science.



A court in Italy has cut a prisoner's jail term because he has genes associated with aggressive behaviour.

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Two conceptual obstacles
in biology:

design teleology
and
psychological essentialism

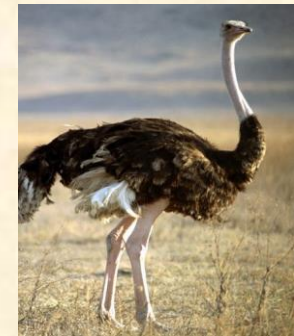
Goal-related thinking misleading in biology

Artifacts' wings were designed
FOR flying



BUT

Birds' wings were NOT designed
FOR flying (e.g., ostriches have
wings but don't fly)



Misconception based on **design teleology**: characters of organisms are intentionally designed for a role.

Kelemen (2012)

Kampourakis. K. (2014)

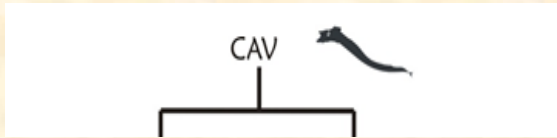
Essence-related thinking misleading in biology



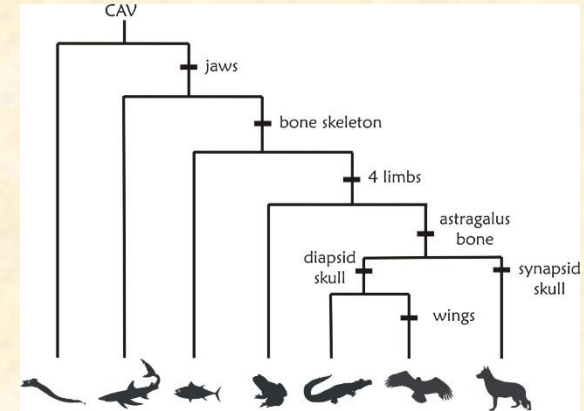
Artifacts have
fixed essences



BUT



Organisms do not
have fixed essences

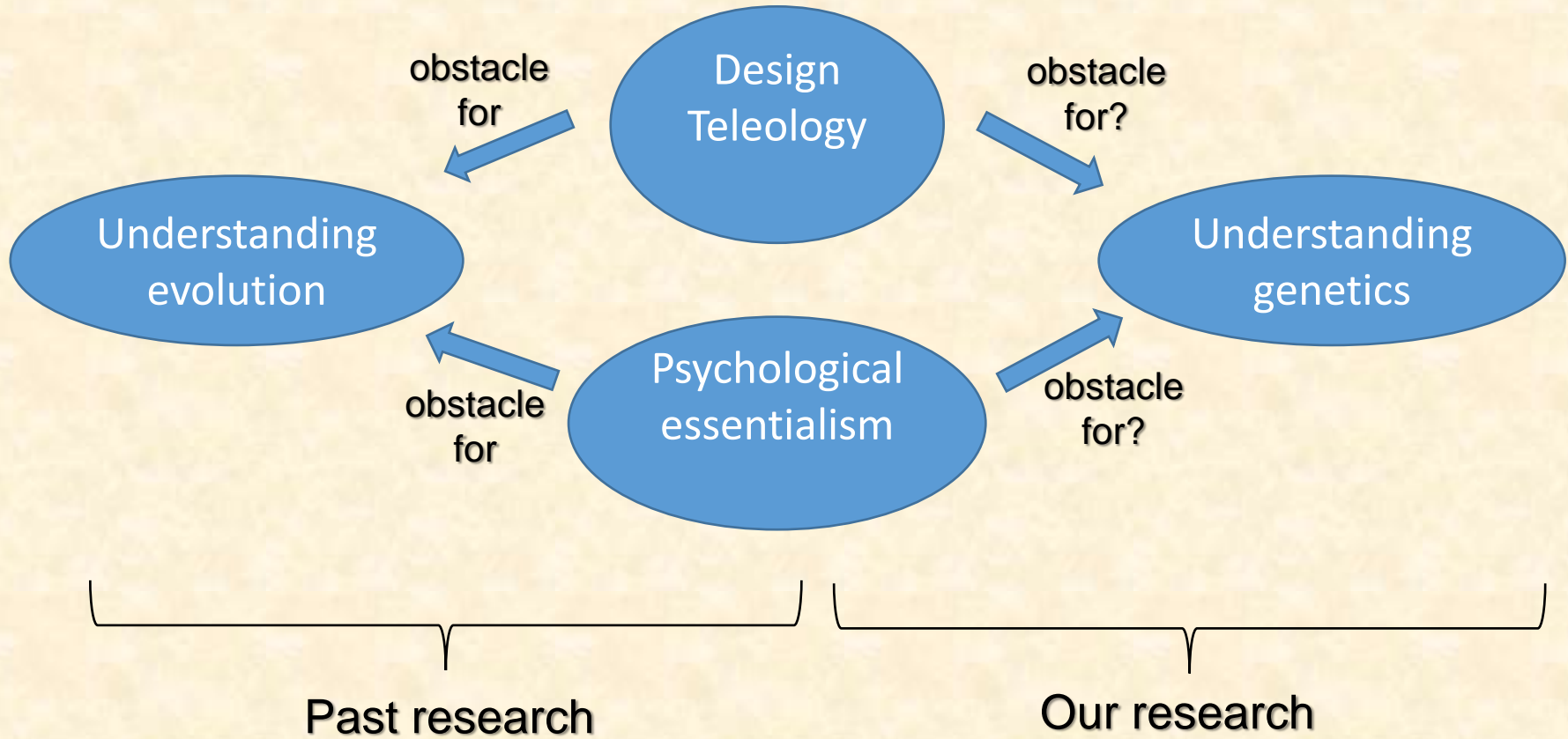


Misconception based on **psychological essentialism**: Characters of organisms remain fixed.

Gelman et al. (2012)

Kampourakis (2014)

Goal: investigating correlations between ...



Dar-Nimrod et al. (2011)

Gould et al. (2012)

Research questions

- **RQ1:** Do secondary school students exhibit **explicit** genetic teleology and genetic essentialism conceptions?
- **RQ2:** Are there any **implicit** associations between students' genetic and teleological or essentialist conceptions?
- **RQ3:** Are secondary school students **explicit** and **implicit** measures of genetic teleology and genetic essentialism conceptions correlated?

Previous explicit tests

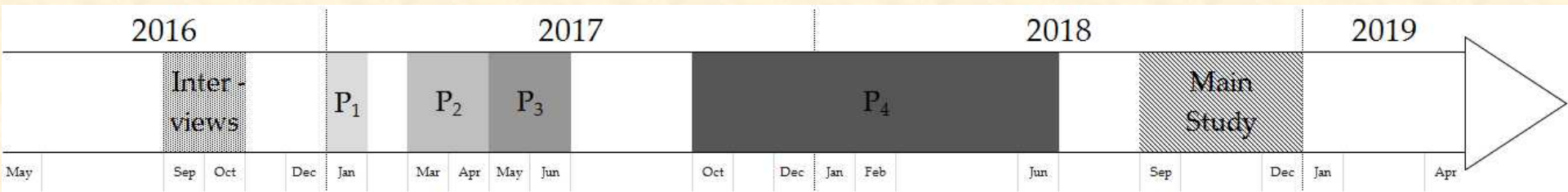
Genetics

- Genetics Literacy Assessments Instrument (Bowling et al., 2008)
- Genetics Concept Assessment (Smith et al., 2008)
- Tsui & Treagust Instrument (2010)
- Fitzgerald-Butt Instrument (2015)
- Public Understanding of Genetics and Genomics (Carver et al, 2017)

Teleology & essentialism in biology

- Coley & Tanner Instrument (2015)
- Stern et al. Instrument (2018)

Project overview



- 714 students
- Interviews, four pilot studies, a main study

The
Genetic Essentialism & Teleology
-
Questionnaire
(GET-Questionnaire)

GET-questionnaire: Genetics Essentialism & Teleology

- 20 items:
 - > 10 genetic teleology (GT)
 - > 10 genetic essentialism (GE)

Construct	Sub-construct
Genetic teleology (GT)	GT about past processes
	GT about future processes
Genetic essentialism (GE)	homogeneity of genes
	fixity of genes

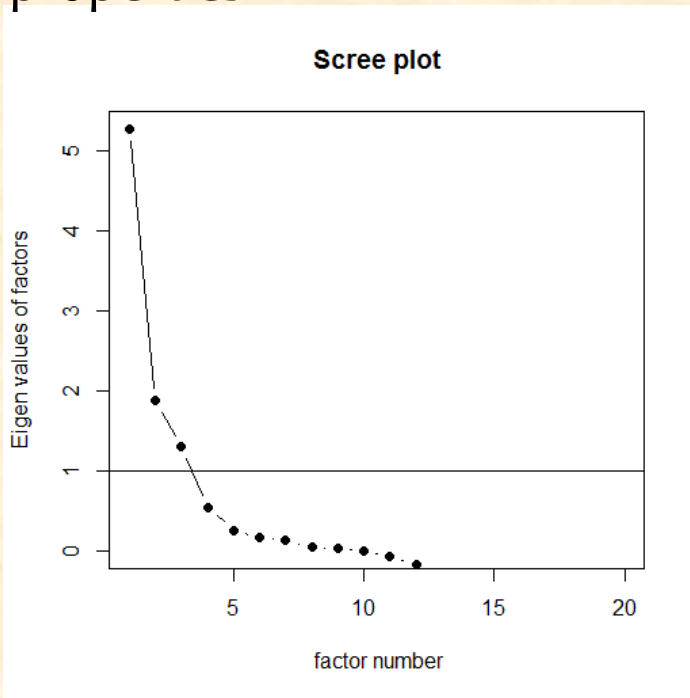
GET-questionnaire: Genetics Essentialism & Teleology

Items

Genetic Teleology (GT)	<i>Our brain is much bigger than the one of cave men. Thus, genes associated with a big brain:</i>
1) design-based teleology	have been designed for several roles such as solving complex problems.
2) need-based teleology	have appeared for satisfying several needs such as solving complex problems.
3) natural teleology	have appeared by chance and were selected for several effects such as solving complex problems.
Genetic essentialism (GE) (homogeneity)	<i>If we analyze the genes of Neanderthals (a prehistoric human group), we will identify:</i>
1) psychological essentialism	genes specific to them
2) moderate essentialism	many genes different from ours
3) weak essentialism	few genes different from ours
Genetic essentialism (GE) (fixity)	<i>A person with Alzheimer's disease has memory difficulties because of a dysfunctional brain. We assume that in a given family everyone has a good memory. Therefore there are only genes associated with a well-functioning brain. A descendant in this family :</i>
1) psychological essentialism	will have a good memory, because the genes associated with a well-functioning brain always remain fixed.
2) moderate essentialism	will have a good memory, because the genes associated with a well-functioning brain are fixed, even though other may change.
3) weak essentialism	may have Alzheimer's disease, if the genes associated with a well-functioning brain change into genes associated with Alzheimer.

GET-questionnaire: Genetics Essentialism & Teleology

- Acceptable to good psychometric properties

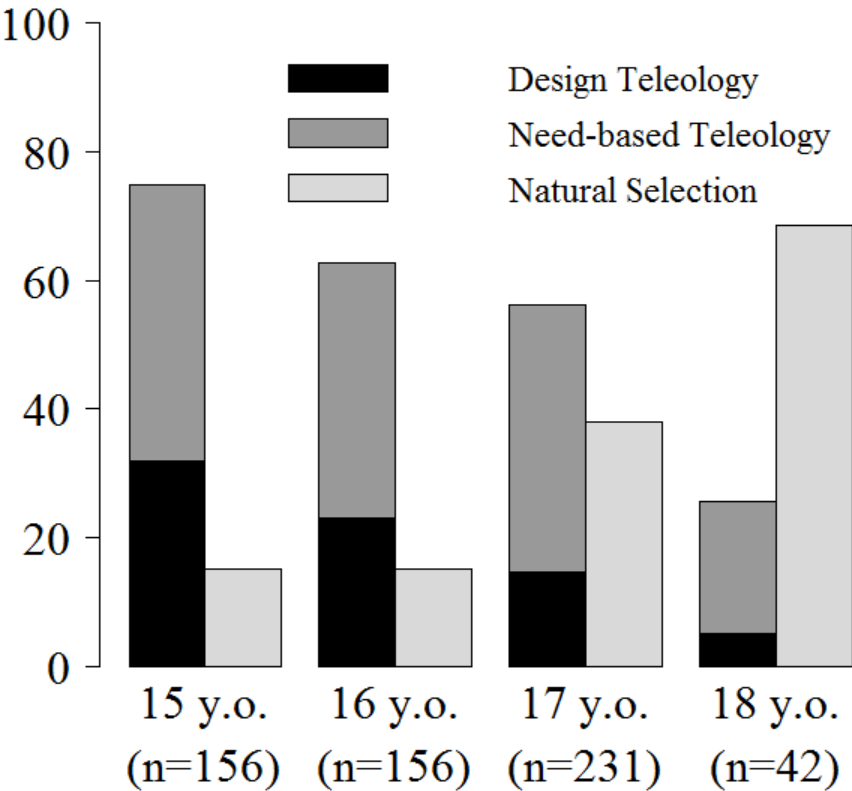


Items	Factors		
	Genetic Teleology	Genetic Essentialism (within-group homogeneity of genes)	Genetic Essentialism (fixity of genes)
GT1 Opposable Thumbs	0.83		
GT2 Big Brain	0.78		
GT3 Bipedalism	0.82		
GT4 Communication	0.45		
GT5 Sociability	0.66		
GT6 Cellulose Digestion	0.68		
GT7 Antibodies Production	0.67		
GT8 Ultraviolet Protectio	0.78		
GT9 High Heat Protection	0.75		
GT10 Radiation Protection	0.72		
GE1 Neanderthals		0.57	
GE2 Chinese People		0.55	
GE3 Chimpanzees		0.67	
GE4 Eskimoos		0.53	
GE5 Baboons		0.78	
GE6 Daltonism			0.57
GE7 Breast Cancer			0.64
GE8 Dwarfism			0.58
GE9 Diabete			0.64
GE10 Alzheimer's disease			0.71
Cronbach Alpha	0.87	0.64	0.65
Cronbach Alpha Interval of Confidence (at 5% level)	[0.85, 0.89]	[0.59, 0.68]	[0.60, 0.71]

- Structural analysis: 3 dimensions:
 - > genetic teleology (10 items)
 - > genetic essentialism-homogeneity (5 items)
 - > genetic essentialism-fixity (5 items)

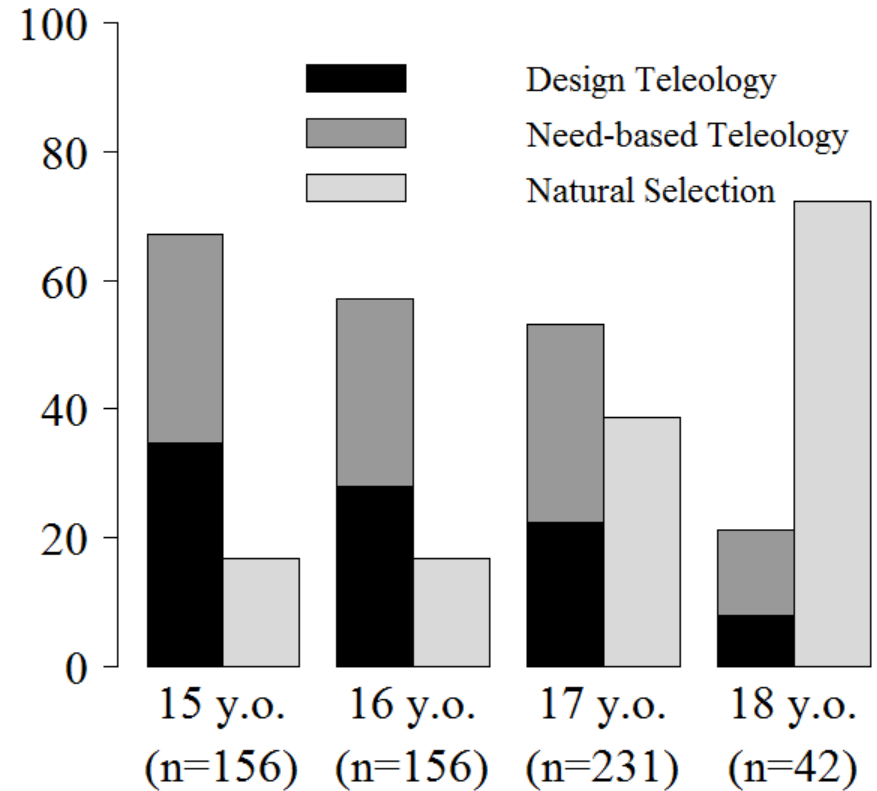
GT-misconceptions significantly decrease with age

GT-past items



Significant differences
 $F(3,36.46)= 11.4, p<0.001$

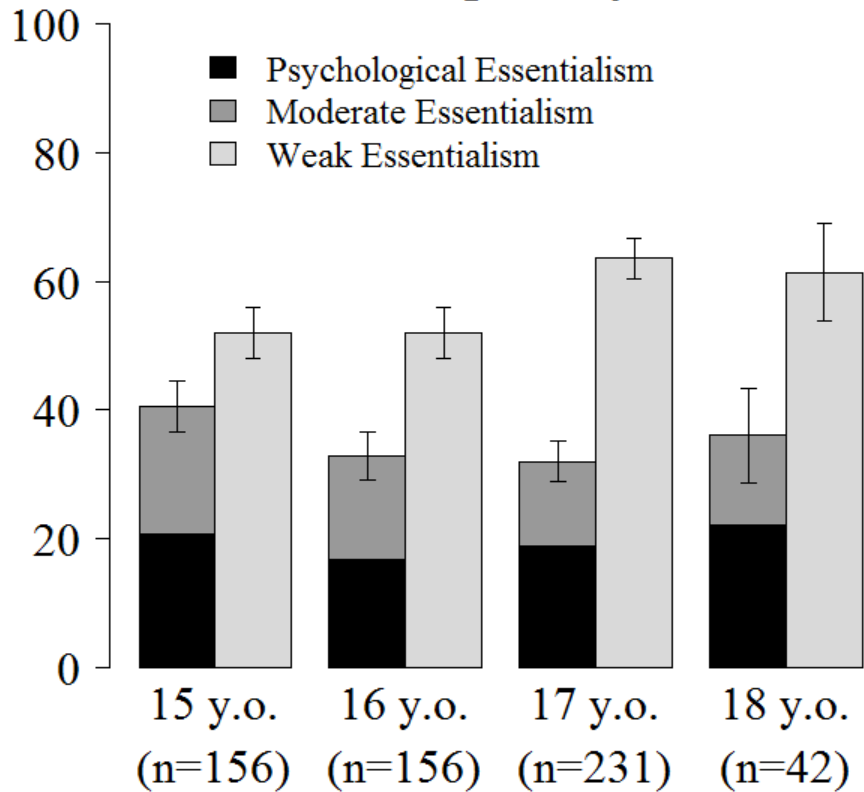
GT-future items



Significant differences
 $F(3, 36.94)= 9.17, p<0.001$

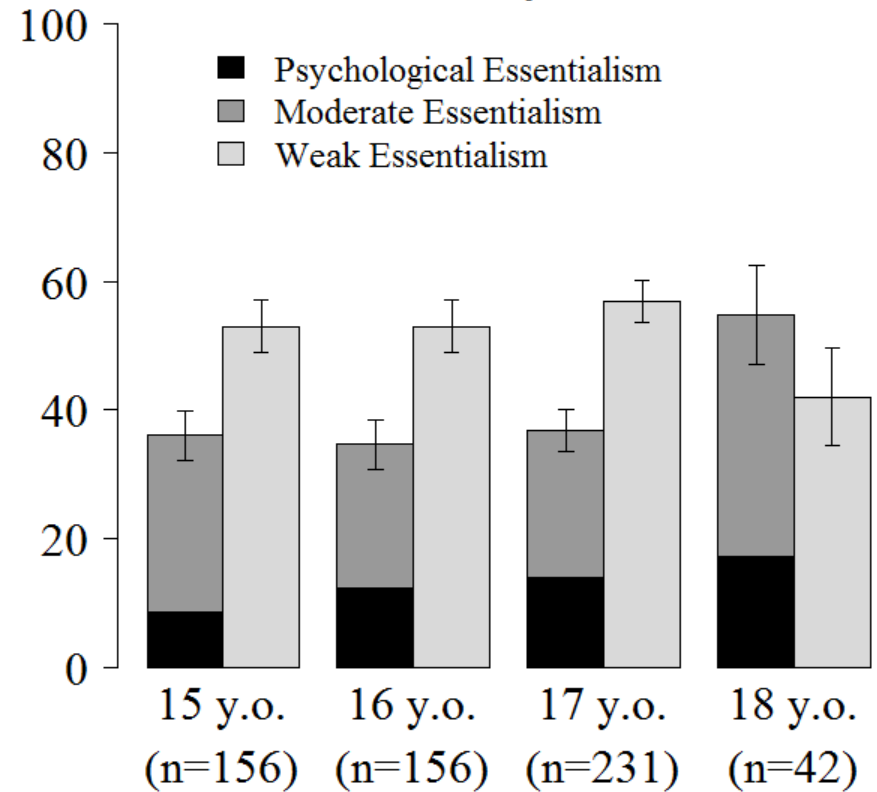
GE-misconceptions do not significantly decrease with age

GE-homogeneity items



Non-significant differences
 $F(3,36.96)=1.37, p=0.27$

GE-fixity items



Non-significant differences
 $F(3,39.4)=1.48, p=0.23$

The
Genetic Essentialism & Teleology
-
Implicit Association Test
(GET-IAT)

Past research using the implicit association test (IAT)

gender-career

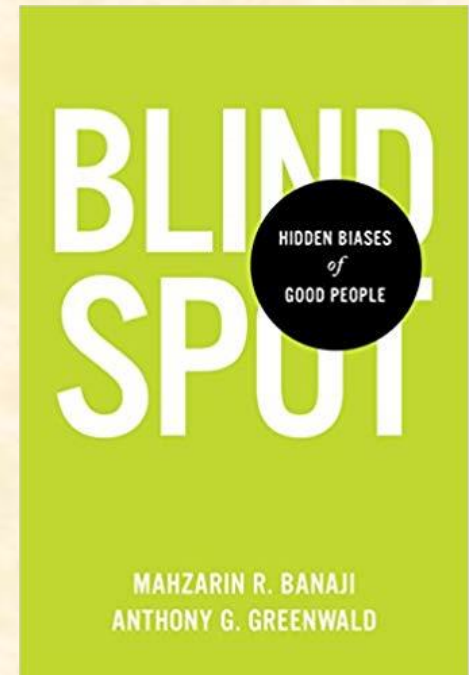
“male & work” and “female & family” association
> endorsed by 75% male and by 80% women participants

ethnicity

“white & good” and “black & bad” association
> 75% of the participants faster for “white preference”

genetics

> significant «genes & fate» association



Gould et al. (2012).

<https://implicit.harvard.edu>

The GET-IAT

Genetics | Environment

Genetics	Environment
Gene	Natural Events
Genome	Change of Environment
Genetic Material	Climate
Genetic Information	Temperature
Chromosome	Atmospheric Pressure
DNA	Luminosity
Genetic heritage	Radiation
Heredity	Humidity

Goal | Chance

Goal	Chance
Intention	Accident
Planning	Luck
Goal	Coincidence
Purpose	Uncertainty
Plan	Lottery
Target	Raffle
Destination	Contingency
Aiming	Dice roll

Stability | Change

Stability	Change
Preservation	Métamorphosis
Permanence	Novelty
Continuity	Difference
Constancy	Transformation
Durability	Modification
Immobility	Discontinuity
Equilibrium	Reform
Fixity	Renewal

GET-IAT practical task screenshot

Appuyez sur la touche "E" pour

génétique (genetics)

ou (or)

but (goal)

Appuyez sur la touche "I" pour

(environnement) **environnement**

(or) **ou**

(chance) **hasard**

intention
(intention)

Students are asked to classify the word in the middle of the screen to the left or the right category.

Translations of the original words (French) are in brackets.

Summary of the GET-IAT tasks

IAT				
TASK	TRIALS	FUNCTION	ITEMS ASSIGNED TO LEFT-KEY RESPONSE	ITEMS ASSIGNED TO RIGHT-KEY RESPONSE
1	20	PRACTICE	GOAL	CHANCE
2	20	PRACTICE	GENETICS	ENVIRONMENT
3	40	TEST	GENETICS & GOAL	ENVIRONMENT & CHANCE
4	20	PRACTICE	CHANCE	GOAL
5	40	TEST	GENETICS & CHANCE	ENVIRONMENT & GOAL

Compatible Response

Incompatible Response

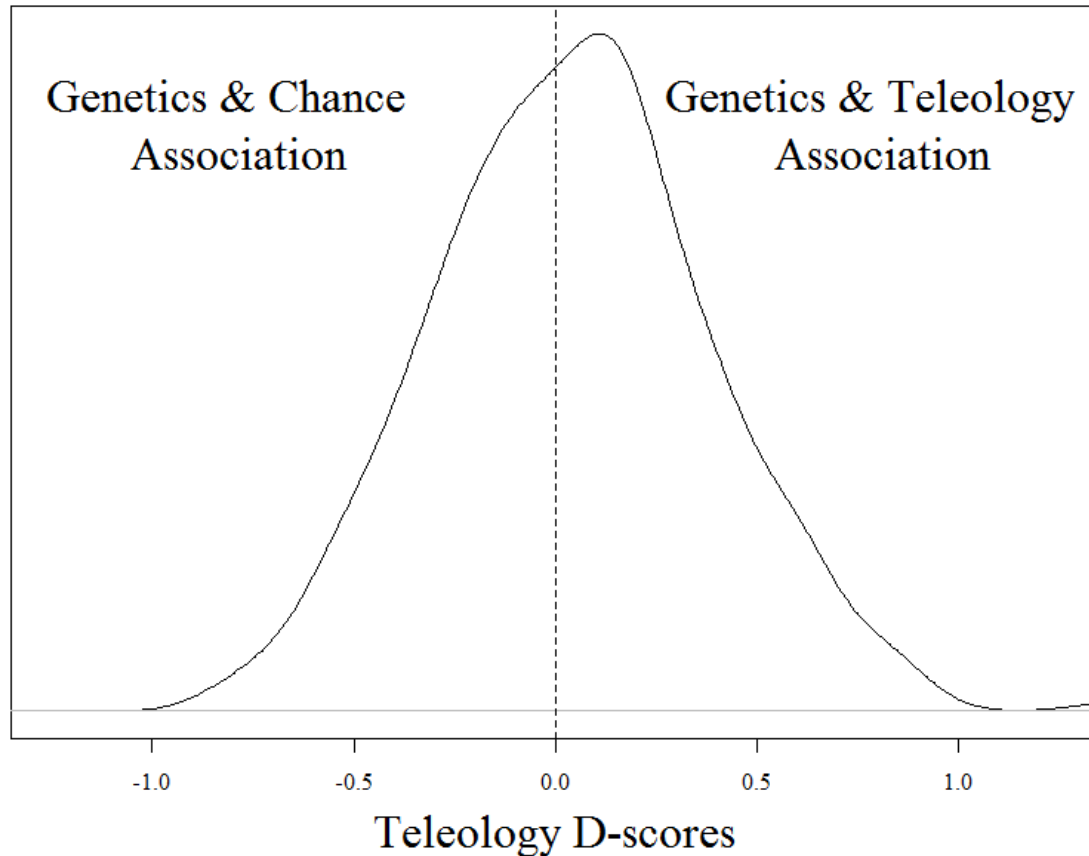
D-scores definition

$$D = \frac{IRL - CRL}{SD}$$

where:

- > **CRL** (“Compatible response latency”): average latency for blocks of trials designed to be easy (i.e., associating Goal and Genetics)
- > **IRL** (“Incompatible response latency”) is the average latency for blocks of trials designed to be difficult (i.e., associating Chance and Genetics)
- > **SD**: within-individual standard deviation of response latencies calculated across the compatible and incompatible items/trials

GET-IAT distribution of D-scores – Teleology



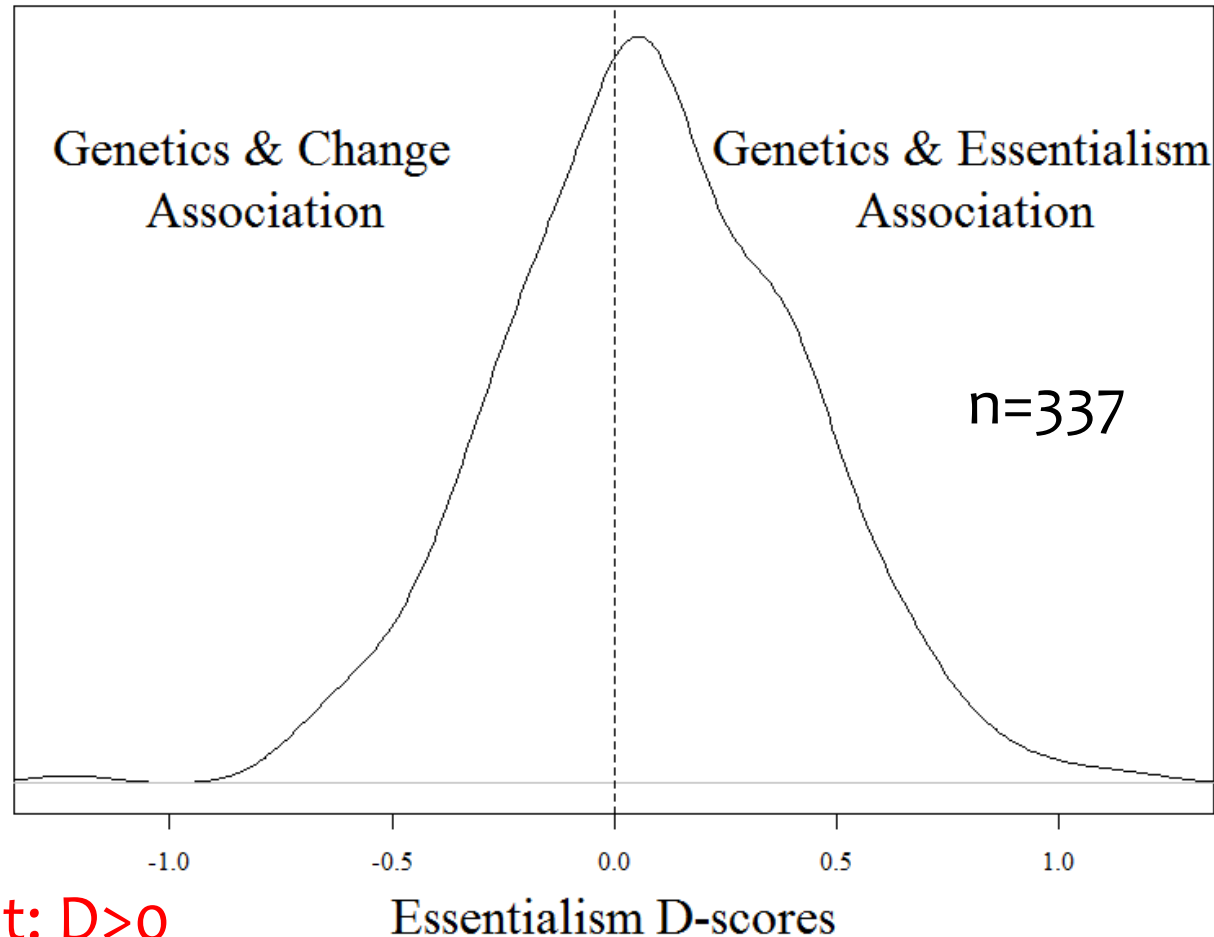
n=337

Test: $D > 0$

Significant Genetics & Teleology association

$t(336) = 2.51, p = 0.006$

GET-IAT distribution of D-scores - Essentialism

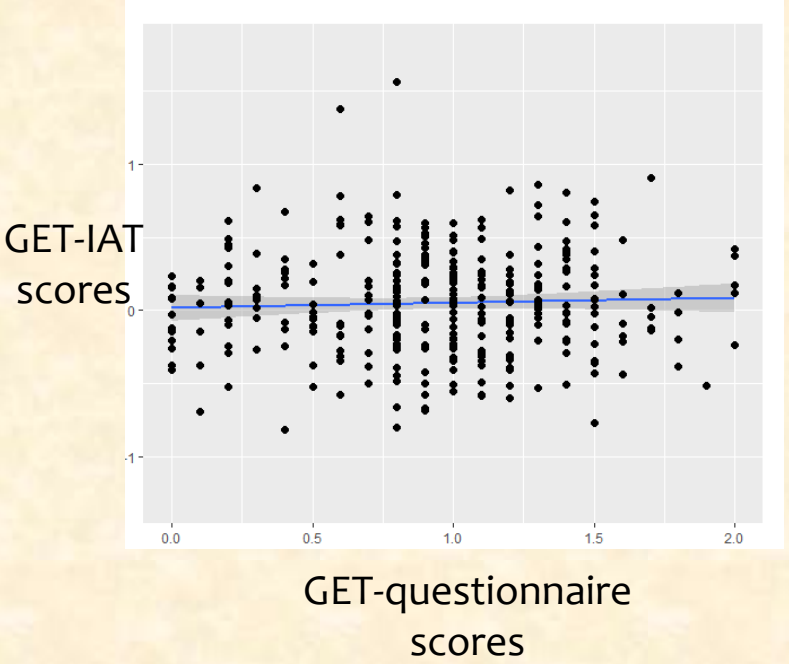


Test: $D > 0$

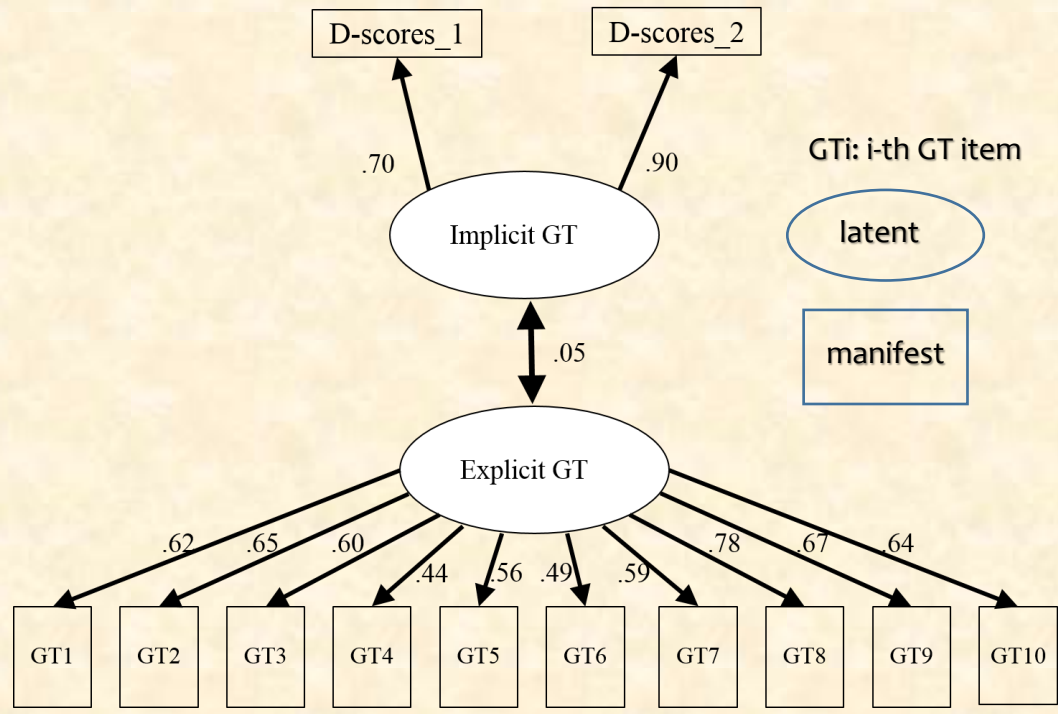
Significant Genetics & Essentialism association

$t(336) = 4.34, p < 0.001$

Genetic Teleology (GT): NO correlation between GET-Questionnaire (explicit) scores and GET-IAT (implicit) scores

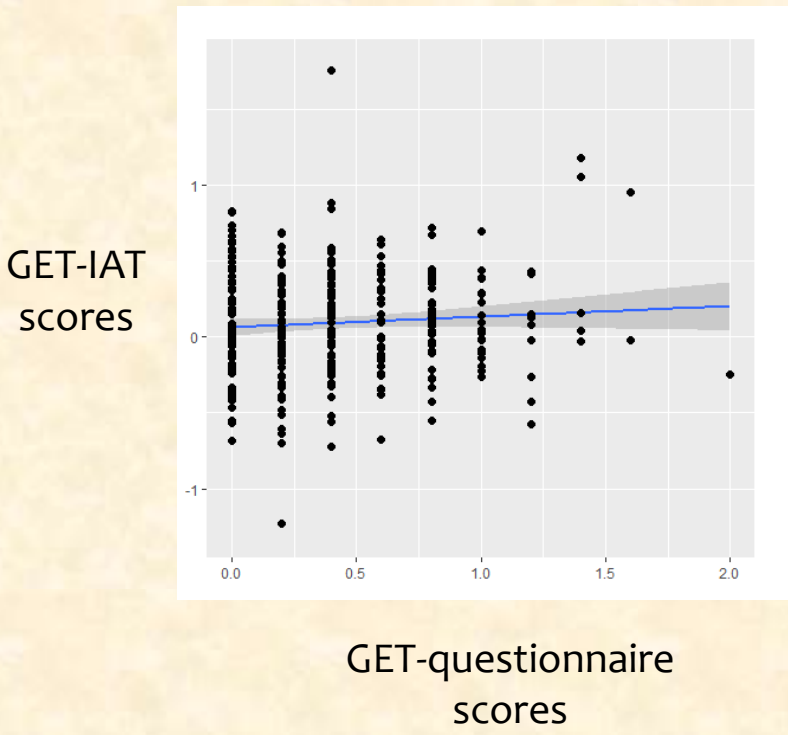


Non-significant Pearson correlation test: $r(332)=0.04, p=0.43$

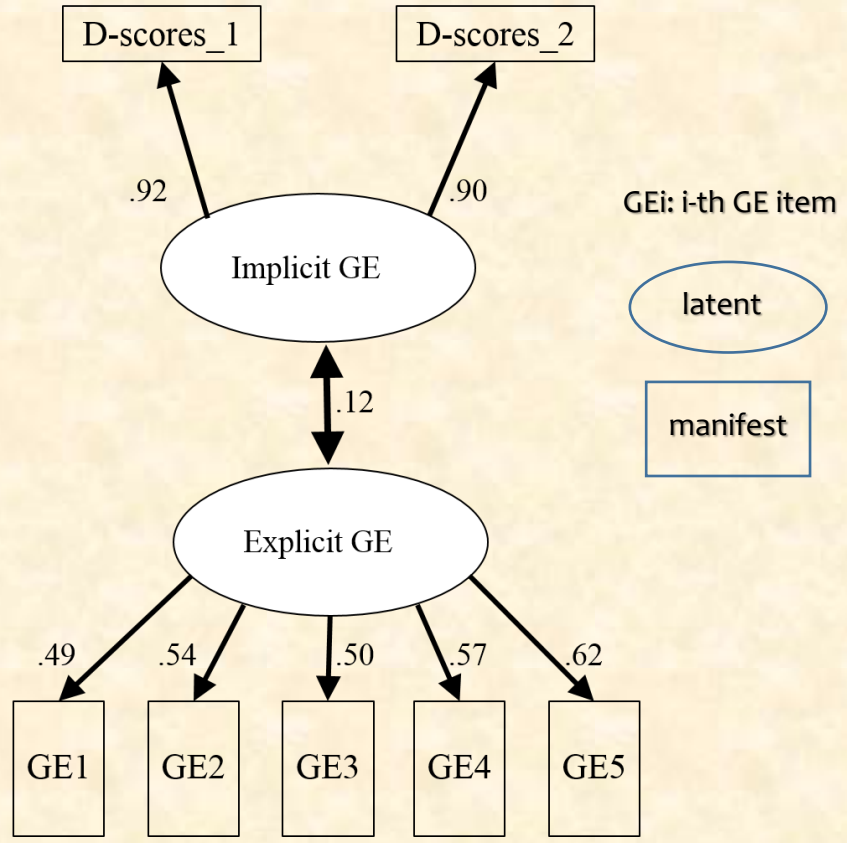


Structural equation modeling
 Non-significant correlation of latent
 Explicit GT and latent Implicit GT:
 $r=.05, p=0.42$

Genetic Essentialism (GE): NO correlation between GET-Questionnaire (explicit) scores and GET-IAT (implicit) scores



Non-significant Pearson correlation test: $r(332)=0.08, p=0.16$



Structural equation modeling
 Non-significant correlation of latent
 Explicit GE and latent Implicit GE:
 $r=.12, p=0.16$

Conclusions

- **RQ1:** Do secondary school students exhibit **explicit** genetic teleology and genetic essentialism conceptions?
 - > yes, among all ages
 - > genetic teleology conceptions significantly change with age
 - > genetic essentialism conceptions DO NOT significantly change with age
- **RQ2:** Are there any **implicit** associations between students' genetic and teleological or essentialist conceptions?
 - > yes, genetics & teleology association
 - > yes, genetics & essentialism association
- **RQ3:** Are secondary school students **explicit** and **implicit** measures of genetic teleology and genetic essentialism conceptions correlated?
 - > no correlation observed for teleology nor essentialism

Discussion

- **Explicit genetic teleology conceptions significantly change with age, but not explicit genetic essentialism conceptions**

-> while illegitimate genetic teleology conceptions are addressed by teaching natural selection, it might also be worth explicitly addressing genetic essentialism conceptions at school.

- **Significant genetics & teleology and genetics & essentialism associations**

-> the first association is confirmed by another study ('genes & fate', Gould & Heine, 2012). As these associations seem to persist even after teaching, students and teachers should at least be aware of their existence.

- **No significant correlations between explicit and implicit measures**

-> possible causes: motivational biases in explicit selfreports, or lack of introspective access to implicitly assessed representations (Hofmann et al., 2005)

-> idea: administer the GET-IAT under time-pressure conditions, in order to increase the convergence of the GET-questionnaire and the GET-IAT scores.

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Contributions:

1. Conceptualization 2. Data curation 3. Formal analysis 4. Methodology 5. Supervision

References

Blanton, H., Jaccard, J., & Burrows, C. N. (2015). Implications of the Implicit Association Test D-Transformation for Psychological Assessment. *Assessment*, 22(4), 429-440. <https://doi.org/10.1177/107319114551382>

Dar-Nimrod, I., & Heine, S. J. (2011). Genetic Essentialism : On the Deceptive Determinism of DNA. *Psychological Bulletin*, 137(5), 800-818. <https://doi.org/10.1037/a0021860>

Gelman, S. A., & Rhodes, M. (2012). “Two-Thousand Years of Stasis” : How Psychological Essentialism Impedes Evolutionary Understanding. In K. S. Rosengren, S. Brem, E. M. Evans, & G. Sinatra (Éds.), *Evolution Challenges : Integrating Research and Practice in Teaching and Learning about Evolution*. Oxford University Press. <http://www.oxfordscholarship.com/view/10.1093/acprof:oso/9780199730421.001.0001/acprof-9780199730421-chapter-1>

Gould, W. A., & Heine, S. J. (2012). Implicit Essentialism : Genetic Concepts Are Implicitly Associated with Fate Concepts. *PLOS ONE*, 7(6), e38176. <https://doi.org/10.1371/journal.pone.0038176>

Hofmann, W., Gawronski, B., Gschwendner, T., Le, H., & Schmitt, M. (2005). A Meta-Analysis on the Correlation Between the Implicit Association Test and Explicit Self-Report Measures. *Personality and Social Psychology Bulletin*, 31(10), 1369-1385.

Kampourakis, K. (2014). *Understanding Evolution* (1st éd.). Cambridge University Press.

Kelemen, D. (2012). Teleological Minds : How Natural Intuitions about Agency and Purpose Influence Learning about Evolution. In K. S. Rosengren, S. Brem, E. M. Evans, & G. Sinatra (Éds.), *Evolution Challenges : Integrating Research and Practice in Teaching and Learning about Evolution* (p. 66–92). Oxford University Press. <http://www.oxfordscholarship.com/view/10.1093/acprof:oso/9780199730421.001.0001/acprof-9780199730421-chapter-4>

Stern, F., Kampourakis, K., Delaval, M., & Müller, A. (2020). Development and validation of a questionnaire measuring secondary students’ genetic essentialism and teleology (GET) conceptions. *International Journal of Science Education*, 42(2), 218-252. <https://doi.org/10.1080/09500693.2019.1707905>