Opinion

# First Step to Understand Intergroup Bias and Cohesion from the One World Experiment: A Pilot Project to Evaluate the Effect of the 'Pale Blue Dot' Hypothesis

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The One World Experiment was carried out as a pilot effort in Cape Town, South Africa, to test whether exposure to an astronomy intervention affects empathy and altruism in children. The intervention focused on introducing children to knowledge around the Earth's position in the Universe and collecting data to assess the effect. This paper presents the project background as well as the methodology and results from the project's first phase, designed to understand the possible difference in empathetic response between a child and other "ingroup" and "outgroup" children; for any child, an 'ingroup' child is one belonging to their own social group (in this case, nationality), and an 'outgroup' child is one belonging to a social group other than their own. It is found that the students across the study have a strong cohesion to those of the same nationality but that there is no nationality bias in their feelings towards how other children share their joy with them.Full analysis of the data, which will compare the control group and experimental group results and focuses on the impact of astronomy intervention, is underway for future publication.

## Introduction

The Pale Blue Dot is a famous image of Earth taken by the Voyager 1 spacecraft on 14 February 1990, when it was around 6 billion kilometres from us. In this picture, taken at the suggestion of the astronomer and science communicator Carl Sagan, Earth appears as a pale blue dot, a tiny point of light, less than a pixel in size. Over the years, this image has come to symbolise our place in the Universe, the connection we have to one another as well as to the planet. As Sagan later wrote in his book, the image 'underscores our responsibility to deal more kindly and compassionately with one another and to preserve and cherish that pale blue dot, the only home we've ever known'.[1]

The image and the philosophy behind the Pale Blue Dot have inspired awe and excitement in many people around the world. It is assumed that knowing one's place in the Universe alters perception and induces more empathy towards fellow humans. Indeed, astronomy has been employed as a tool for diplomacy and international cooperation[2, 3]. In our era of unprecedented migration, and anti-immigration sentiments, astronomy could be viewed as a panacea that can bring people together. Astronomy outreach projects provide anecdotal evidence that looking through a telescope provides a unique perspective that can induce empathy and lead people to overcome hostility.

From October to November 2015, the astronomy outreach project 'One World Experiment' was carried out among 938 secondary school students in Cape Town, South Africa. The IAU Office of Astronomy for Development (OAD) and Hosei University together with the South African Astronomical Observatory conducted a randomised controlled trial (RCT). RCTs are often considered the ideal study design to measure and evaluate the effectiveness of interventions. The Consolidated Standards of Reporting Trials statement (Begg et al., 1996) was developed as guidelines for designing and reporting RCTs.

This experiment aimed to test whether exposure to an astronomy intervention would affect intergroup biases and other-regarding preferences (empathy and resource allocation) in children. Intergroup bias, also known as ingroup-outgroup bias, is the tendency to favour members of one's own group over others (Sumner, 1906). People with intergroup bias may perceive their own group members positively simply because of the ingroup and may view the outgroup negatively simply because it belongs to another grouping (Bigler et al., 1997). Empathy, altruism and prosociality are critical foundations for a stable human society. Research shows a tendency for individuals to feel more empathy and engage in more prosocial behaviour towards individuals categorised as belonging to their own social group relative to other groups. Failure to empathise is more likely if 'the sufferer is socially distant' (Cikara et al., 2011).

Although empathy is a key prosocial response, (intergroup) biases develop at a very young age. This intervention introduced children aged 9 to 11 years to astronomical perspectives of Earth's position in the greater cosmos (e.g., a view of Earth from space appearing as a pale blue dot). The intervention emphasised humanity as a social group to reduce intergroup biases in empathy and increase prosocial behaviours towards those outside of nationally defined 'ingroup' categories. From the viewpoint of space, viewing the Earth without national boundaries often made astronauts change their views of the world

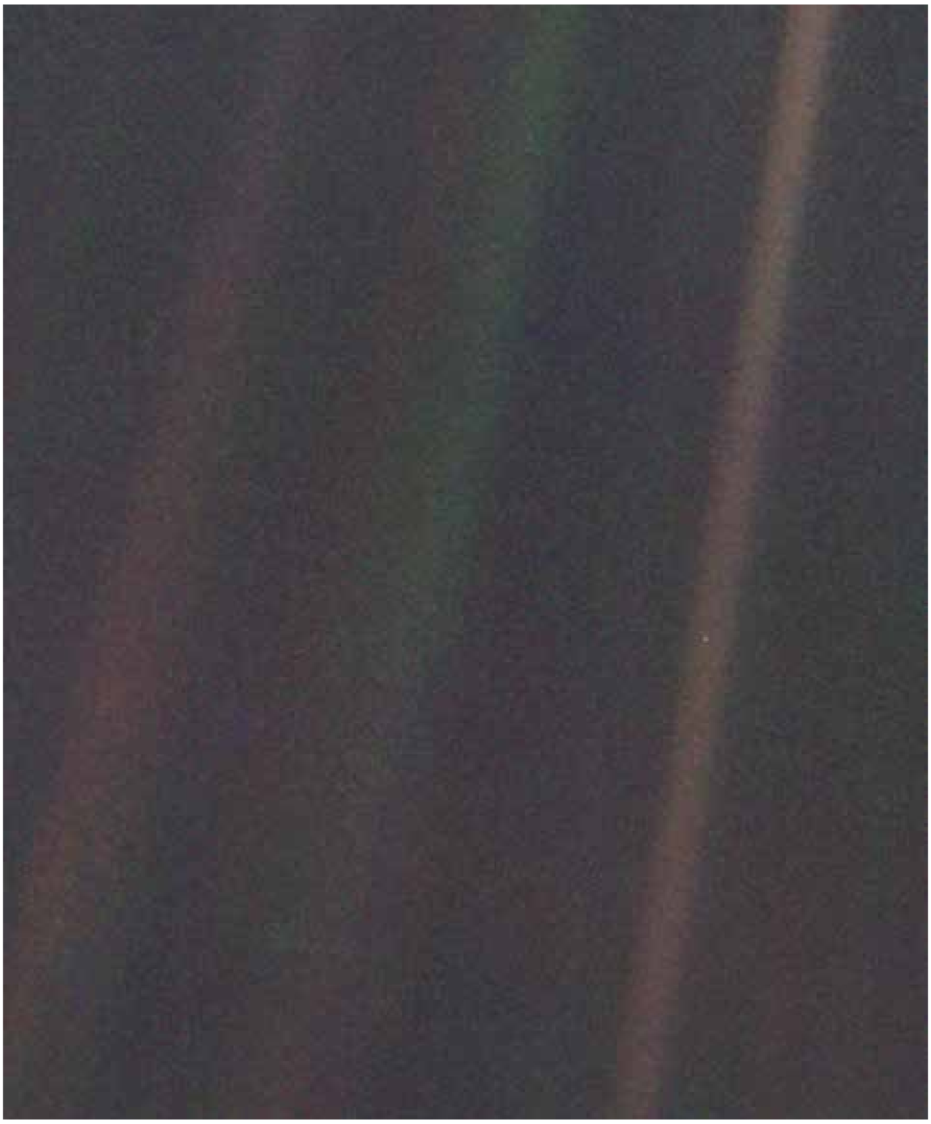

**Figure 1.** *The Pale Blue Dot is an image of the Earth taken by the Voyager 1 spacecraft from a distance of more than 4 billion miles away. From this distance, Earth is a mere point of light, less than the size of a picture element even from a narrow-angle camera. Credit: NASA/JPL*

by involving the sense of universal brotherhood. This experience is known as the 'overview effect' (Yaden et al., 2016). The intervention was designed like a simulated experience of the overview effect.

It must be mentioned that this intervention was performed at a small scale and low cost, as a proof of concept. We hope this pilot initiative will guide others interested in repeating this experiment.

## Background

Astronomy communication with the public takes many different forms. Traditional astronomy education activities, marked by awareness-raising actions such as sky observations and public lectures fall under the broad category of outreach. These activities aim to motivate the audience by providing a window into the most fascinating aspects of astronomy. They are meant to be fun experiences that introduce exciting themes of science and astronomy to wide swathes of people.

Such activities routinely inspire thousands, if not millions, around the world. Many scientists are able to pinpoint their interest in science to a particular outreach event, but this impact is broadly recorded anecdotally. These events have a hit-or-miss approach about their impact and typically tend to attract people with an established interest in science. Without methodical evaluations, it is hard to measure the impact of such edutainment.

Evaluations are essential to measure the impact of interventions. Evaluation is defined as the 'systematic, objective assessment of an ongoing or completed intervention, project, policy, programme, or partnership. Evaluation is best used to answer questions about what actions work best to achieve outcomes, how and why they are or are not achieved, what the unintended consequences have been, and what needs to be adjusted to improve execution'[4].

Different types of evaluation are used to address different dimensions of project impact and effectiveness and are of interest to different stakeholders. For example, process evaluations focus on implementation and how, for whom and under what conditions a project worked; impact or outcome evaluations measure significant changes attributable to the project and whether and to what extent target outcomes were achieved; and economic evaluations measure cost-effectiveness. It is important to note that not all projects can be evaluated, such as those without clearly defined goals and projects that do not aim to change observable outcomes.

An RCT is one type of impact evaluation in which participants are randomly assigned to groups that receive an intervention or serve as the control group which does not receive the intervention. RCTs are considered the gold standard in impact evaluation. By randomly assigning participants to the experimental and control groups and comparing the outcomes between the groups, the effectiveness of a project can be measured. Since participants in an RCT are randomly assigned, any differences in outcomes can be attributed to the programme or intervention rather than other factors[5].

## Experiment

The intervention aimed to foster the development of a social identity based on a 'common humanity'. By placing all of humanity as the ingroup and any other life (outside of Earth) as the outgroup,

***Figure 2.*** *The astronomy outreach project, 'One World Experiment', was carried out among 938 secondary school students in Cape Town, South Africa. Credit: IAU Office of Astronomy for Development*

the intervention aimed to reduce the salience of national and ethnic identities and increase empathy and prosociality toward individuals in different national groups.

The primary outcome of interest is whether there is any immediate effect of the intervention on children's helping behaviour toward anonymous ingroup versus outgroup members.

The null hypothesis is that there will be no difference in primary and secondary measures between students in the experimental and control groups. The experimental hypotheses are that students in the experimental group will report higher cohesion and higher levels of empathy with the outgroup than students in the control group.

## Experimental design

The experiment was designed as a cluster RCT (in which the unit of randomisation is a group or cluster rather than an individual) with an experimental and control arm. The cluster unit of intervention is a class group. The sample size is the average number of students per class group multiplied by the number of class groups that participated in the trial. These class groups were part of schools that were contacted in the target area and agreed to participate in the study. All of the schools are located in the same area and share a similar setup and level of infrastructure.

For students in these selected schools, their own national group was South Africa (the ingroup). The outgroup was chosen such that it differed from the ingroup along only one dimension. Kenya was chosen as the outgroup because it is an outgroup with which the children are somewhat familiar, and it is not associated with overtly negative stereotypes and does not differ along the race dimension.

## Astronomy activity

The intervention is designed to introduce children to the inter-connectedness of the human species and the bond that we share with the planet. This can be achieved by using astronomy as a tool, i.e. by exposing them to the concept of the Pale Blue Dot[1].

We created a video using a combination of Google maps, Mitaka software, Google Street view and NASA's 'Eyes on the Sky' application. The instructor takes the children on a tour of chosen locations in different countries on Earth and then through the Solar System, stopping over for a brief exploration of the surface of Mars.

## Measurement

The astronomy activity was preceded or followed by the measurement for the control and experimental groups, respectively.

Control — The control group receives the measurement first, followed by the astronomy intervention.

Experiment — The experiment group is administered the astronomy intervention, followed by the measurement.

## Data Collection

The data were gathered from 938 students (472 boys and 466 girls). After incomplete data were removed, the data from 683 students (319 boys and 364 girls) were used in this research.

The measurement process involved two parts:

Voting — This was intended to test the helping behaviour of the children toward children from other groups (in this case, nationalities). Each student had a card with envelopes affixed under a gender-neutral picture of a child from their country (ingroup) and a child from a chosen foreign country (outgroup). Students were given 3 tokens each and told that each token represents 1 unit of currency. They were told that whichever envelope they put the token in, a real donation of that amount would be made to the child whose envelope they chose.

Questionnaire — Students were asked to mark responses to the following questions on a separate card. There were two sets of five questions, one for the home country and the other for the chosen foreign country. The intervention provider explained each question.

*Question 1. How similar do you think this child is to you?*
*A. Very different/B. A little different/C. Neither different nor similar/*
*D. More similar than different/E. Very similar*

*Question 2. How would you feel if something good happens to this child?*
*A.I don't care at all/B. I feel neutral, okay with it/C. I feel happy/D. I feel very happy/E. I feel very, very happy*

*Question 3. If something good happens to you, how do you think this child would feel?*
*A. The child doesn't care at all/B. The child feels neutral, okay with it/C. The child feels happy/D. The child feels very happy/E. The child feels very, very happy*

*Question 4. How much would you like to play with this child?*
*A.Not at all/B. A little bit/C. Medium/D. I would like to/E. I would really like to*

*Question 5. How would you feel if this child got hurt at school?*
*A. Very sad/B. Sad/C. Medium (not happy)/D. I would not care*

In schools, the astronomy intervention and measurement were carried out in Xhosa (isiXhosa), which is one of the official languages of South Africa, and English.

## Brief summary of the auxiliary analysis

Full analysis of the data, which focuses on the impact of astronomy intervention, is under way within the collaboration. This paper describes the auxiliary analysis of possible differences in responses among other ingroup and outgroup children to the parts of assessment measures with no reference to the astronomy intervention by collectively dealing with experimental and control groups. Correlation analysis was performed to examine the strength and direction of the linear relationship among the answers to the questions.

Students in the same class are more likely to respond in a similar way. The intercluster correlation coefficient (ICC) was calculated to confirm whether there was high similarity between values from the same class or not. The ICC ranges from 0 to 1. A low ICC close to 0 indicates that values from the same class are not similar. On the other hand, an ICC close to 1 indicates high similarity between values from the same class. According to Hox (2002), rules of thumb for interpreting the ICC were as follows:

small: ICC = .05, medium: ICC = .10, large: ICC = .15

ICCs in all questions except q1SA were smaller than .05. The ICC of q1SA was also lower than .10. Since the ICC result show the students in the same class are not highly similar, we performed analysis using individual students' data.

### Box 1: Abbreviations

Abbreviations as shown below were used in our research:

q[n]SA, q[n]K (n: question number)
e.g. q2SA means question number 2 and that the child in the question is a South African child (the ingroup).
e.g. q3K means question number 3 and that the child in the question is a Kenyan child (the outgroup).

[All]: All students (683)

[Boy]: Boy students (319)

[Girl]: Girl students (364)

[vote_SA]: Students who gave more tokens to the South African child than the Kenyan child (541)

[vote_K]: Students who gave more tokens to the Kenyan child than the South African child (144)

## Data analysis procedure

In this paper, four questions (q2SA, q2K, q3SA and q3K) are focused on, and associations among the responses to these are examined. For data analyses, the answer options (A, B, C, D and E) were converted into ordinal variables (1, 2, 3, 4 and 5). From these four questions, two questions were chosen as question combinations. [q2SA–q2K] is the abbreviation used to represent the association of the answer between q2SA and q2K.

### a) Calculating the Spearman rank correlation coefficient

In correlation analysis, a sample correlation coefficient is calculated. The correlation coefficient ranges between –1 and +1. The more the value of the correlation coefficient is closer to +1 or –1, the stronger is the positive or negative correlation between variables. According to Cohen (1992), the rules of thumb for interpreting the correlation coefficient are as follows:

small: $|r|=.10$, medium: $|r|=.30$, large: $|r|=.50$

For example, the linear correlation between the height and weight of children can be interpreted by calculating the correlation coefficient. If this correlation coefficient is closer to +1, the height and weight are strongly positively related.

Depending on the number and type of variables, there are different types of correlation coefficients. In this paper, the direction and strength of the association between two variables are quantified by calculating the Spearman rank correlation coefficient, which is used for ordinal variables, including Likert scales.

### b) Calculating the partial correlation coefficient using the Spearman rank correlation coefficient

When the correlation analysis is performed by calculating the correlation coefficient, the two variables q2SA and q2K are influenced by other variables. The partial correlation coefficient can eliminate this influence.

## Results

Partial correlation coefficients are calculated from correlation coefficients. Among partial correlation coefficients related to question combinations between q2SA, q2K, q3SA, and q3K, five partial correlation coefficients (q3SA-q3K for [vote_K], q2K-q3K for [All], [Boy], [Girl], and [vote_SA]) were higher than the medium effect size of Cohen's index, i.e. 0.30 (Cohen, 1992). For these partial correlation coefficients, confidence interval (CI) was calculated. Further, the p-value of the test for association and the statistical power of the post-hoc analysis for each partial correlation coefficient were summarised, as shown below:

「q2K-q3K」

[All] $r = .33, p < .05, 1\text{-}\beta > .99$, 95% CI [.26, .40]
[Boy] $r = .35, p < .05, 1\text{-}\beta > .99$, 95% CI [.25, .44]
[Girl] $r = .31, p < .05, 1\text{-}\beta > .99$, 95% CI [.21, .40]
[vote_SA] $r = .33, p < .05, 1\text{-}\beta > .99$, 95% CI [.25, .40]

where $\beta$ is the error probability.

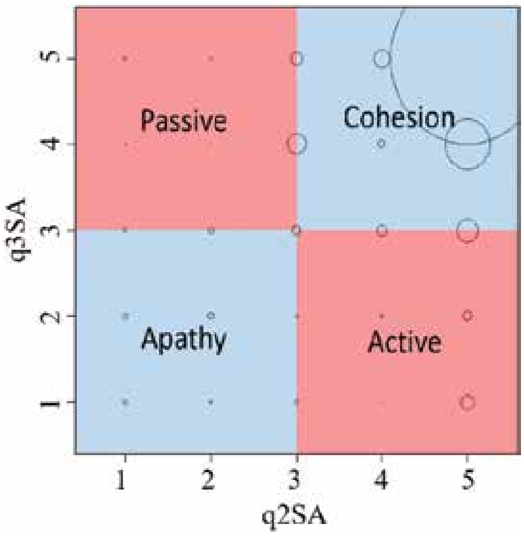


***Figure 3.*** *Bubble chart for q2SA and q3SA [All]. The size of the circle represent the frequency of the answer set to questions. The X-axis and Y-axis show the answer options (from 1 to 5) of q2SA and q3SA, respectively.*

「q3SA-q3K」

[vote_K] $r = .40, p < .05, 1\text{-}\beta > .99$, 95% CI [.25, .53]

With regard to the question combination [q2SA-q3SA], the majority of the students answered 5 for both q2SA and q3SA. The percentage of the answer result (q2SA = 5, q3SA = 5) for each classification is about 40%. Figure 3 shows a bubble chart of the question combination between q2SA and q3SA for [All] divided into four sections.

We found that the correlation of the cohesion among the ingroup and outgroup students can be determined by focusing on the question combination [q3SA-q3K].

[vote_K] and [All] were used taken to compare differences in answer results between these classifications.

Figure 4 shows a bubble chart of [vote_K], while Figure 5 shows one of [All].

The question combination [q2K-q3K] enabled us to examine the impression of the outgroup in detail. For comparison, [vote_SA] from these classifications and [vote_K] were considered. Figure 6 shows a bubble chart of [vote_SA], while Figure 7 shows one of [vote_K].

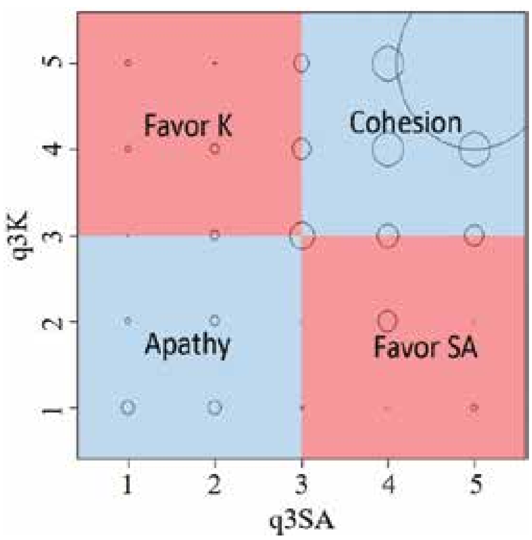


***Figure 4.*** *Bubble chart for q3SA and q3K [vote_K]. The size of the represents the frequency of the answer set to questions. The X-axis and Y-axis show the answer options (from 1 to 5) of q3SA and q3K, respectively.*

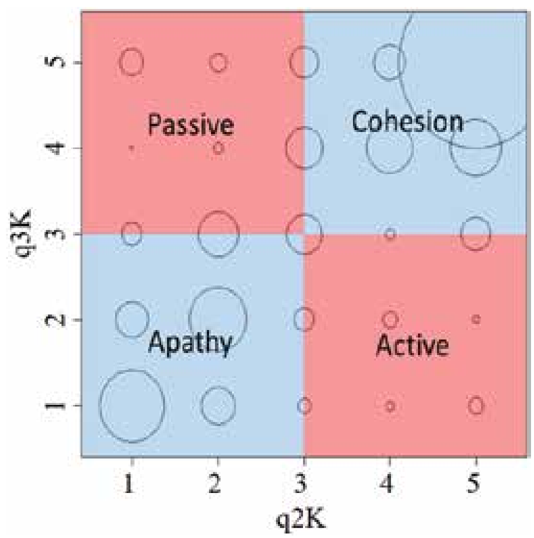


***Figure 5.*** *Bubble chart for q3SA and q3K [All]. The size of the circle represents the frequency of the answer set to questions. The X-axis and Y-axis show the answer options (from 1 to 5) of q3SA and q3K, respectively.*

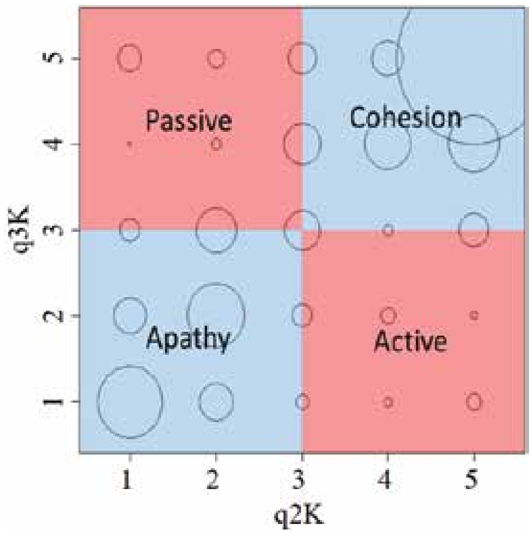


***Figure 6.*** *Bubble chart for q2K and q3K [vote_SA]. The size of the circle represents the frequency of the answer set to questions. The X-axis and Y-axis show the answer options (from 1 to 5) of q2K and q3K, respectively.*

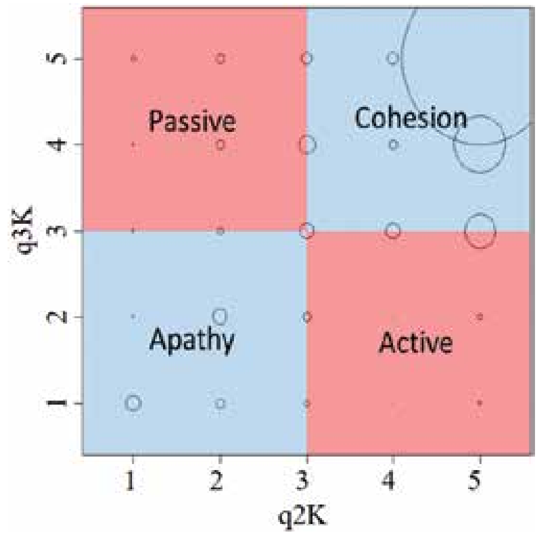


***Figure 7.*** *Bubble chart for q2K and q3K [vote_K]. The size of the circle represents the frequency of the answer set to questions. The X-axis and Y-axis show the answer options (from 1 to 5) of q2K and q3K, respectively.*

## Discussion and Conclusions

The present RCT was implemented as a pilot project to test the feasibility of adding and running a low-cost evaluation component to a typical educational intervention at the school level. The trial and results are important not only in the context of this particular intervention but also for astronomy and science popularisation and outreach activities. Our findings demonstrate that it is possible to run evaluations to better understand the impact of such interventions.

### (1) Strong cohesion among South African children

The interpretation of each section in Figure 3 is as shown below:

The top right section [Cohesion]:
The answers to both q2SA and q3SA are high. In this section, students think they can share the joy with each other in the ingroup.

The top left section [Passive]:
The answer to q2SA is low, while the answer to q3SA is high. In this section, students think they are not interested in sharing the joy with the ingroup, although the ingroup shares the joy with them.

The bottom right section [Active]:
The answer to q2SA is high, while the answer to q3SA is low. In this section, students think they can share the joy with the ingroup, but the ingroup is not interested in sharing the joy with them.

The bottom left section [Apathy]:
The answers to both q2SA and q3SA are low. In this section, students do not think they can share the joy with each other in the ingroup.

As can be seen from the figure, the circle located in the upper right corner (q2SA = 5, q3SA = 5; question combination [q2SA-q3SA]) is particularly large. This indicates that students show strong cohesion with the ingroup in any classification.

### (2) No nationality bias among [vote_K]

The interpretation of each section in Figures 4 and 5 is as shown below:

The top right section [Cohesion]:
The answers to both q3SA and q3K are high. In this section, students think both the ingroup and outgroup share the joy with them.

The top left section [Favor K]:
The answer to q3SA is low, while the answer to q3K is high. In this section, students think the outgroup shares the joy with them.

The bottom right section [Favor SA]:
The answer to q3SA is high, while the answer to q3K is low. In this section, students think the ingroup shares the joy with them.

The bottom left section [Apathy]:
The answers to both q3SA and q3K are low. In this section, students do not think the ingroup or outgroup shares the joy with them.

At the right end of Figure 5, we saw a vertical distribution of answers along q3SA = 5. This indicates that the answer results of q3SA concentrate on 5, while those of q3K scatter from 1 to 5 for [All]. Moreover, it also confirms that these features appear for the classification of [Boy], [Girl], and [vote_SA]. In the case of [vote_K], the majority of answer results particularly concentrate on the upper right corner (q2SA = 5, q3SA = 5) of Figure 4. Additionally, it has been observed that the partial correlation coefficient between q3SA and q3K for [vote_K] is 0.40. This value is higher than the medium effect size of Cohen's index, that is, 0.30 (Cohen, 1992), indicating a remarkable positive correlation in this question combination. These results lead to the conclusion that [vote_K] have no bias about their impression of how the other shares joy with them regardless of whether the other is an ingroup member or outgroup.

Partial correlation coefficients of [q2K-q3K] for each classification are 0.33 [All], 0.35 [Boy], 0.31 [Girl], 0.33 [vote_SA], and 0.28 [vote_K] respectively. In this question combination, partial correlation coefficients for [All], [Boy], [Girl], and [vote_SA] are larger than a medium effect size of Cohen's index, 0.30 (Cohen, 1992).

The interpretation of each section in Figure 6 and Figure 7 is as shown below:

The top right section [Cohesion]:
The answers to both q2K and q3K are high. Students in this section think they can share the joy with the outgroup each other.

The top left section [Passive]:
The answer to q2K is low, while the answer to q3K is high. Students in this section think they are not interested in sharing the joy with the outgroup, while the outgroup shares the joy with them.

The bottom right section [Active]:
The answer to q2K is high, while the answer to q3K is low. Students in this section think they can share the joy with the outgroup, while the outgroup is not interested in sharing the joy with them.

The bottom left section [Apathy]:
The answers to both q2K and q3K are low. Students in this section do not think they can share the joy with the outgroup each other.

As shown in Figure 6, distribution is presented on the diagonal from the bottom left to the top right. It means that a positive correlation indicated by the partial correlation coefficient exists between q2K and q3K for [vote_SA]. Furthermore, it also confirmed that these features appear for the classification of [All], [Boy], and [Girl]. Due to the above results, it can be seen that students mainly show their cohesion with not only the ingroup but also the outgroup for these four classifications. However, there are positive correlations interpreted from their partial correlation coefficients above 0.30, indicating that the degree of sharing the joy with the outgroup is correlated with the impression of how the outgroup shares the joy with the students. Further, students can roughly be divided into two groups on the basis of the distribution features. The first group consists of students who think they can share the joy with the outgroup. The other group is indifferent to sharing the joy with the outgroup. Compared to other classifications, the majority of answer results for [vote_K] are particularly concentrated in the upper right corner (q2SA = 5, q3SA = 5) of Figure 7. As is evident from this result, students in the classification of [vote_K] strongly believe they can share the joy with the outgroup. These results indicate that the strength of cohesion almost all of the students show with the outgroup varies widely, whereas [vote_K] show high cohesion with the ingroup as well as the outgroup.

The full analysis will consider the impact of astronomy intervention on ingroup-outgroup bias. The first step result presented here will form the basis to compare the difference among the complete dataset versus the control group and experimental group about the nationality cohesion and nationality bias following exposure to the "pale blue dot" message.

All the publications based on this study only present summary statistics and ensure that neither any school nor any of the children are identifiable. Participation in this study was entirely voluntary.

## Notes

1. The Pale Blue Dot available at http://www.planetary.org/explore/space-topics/earth/pale-blue-dot.html
2. Columba-Hypatia: Astronomy for Peace available at http://www.astro4dev.org/blog/category/tf2/columba-hypatia-astronomy-for-peace/
3. Madsen, Astronomy and international science diplomacy, IAU General Assembly, Meeting #29 available at http://adsabs.harvard.edu/abs/2015IAUGA..2244281M
4. Monitoring and Evaluation, IAU Office of Astronomy for Development available at http://www.astro4dev.org/monitoring-evaluation/
5. Introduction to Evaluations by Abdul Latif Jameel Poverty Action Lab available at https://www.povertyactionlab.org/research-resources/introduction-evaluations

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## Links

1. http://www.astro4dev.org/
2. http://www.intergroupneurosciencelaboratory.com/
3. http://www.saao.ac.za/outreach/scbp/
4. http://www.tobitate.mext.go.jp/about/english.html
5. https://www.iau.org/
6. http://www.dst.gov.za/
7. http://www.nrf.ac.za/

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