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Exploring the use of positive humour as a tool in science communication: do science and non-science undergraduates differ in their receptiveness to humour in popular science articles?

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Abstract

This study aims to test for differences in the receptiveness of science and non-science undergraduates to positive, non-aggressive humour being used in a science article, as an exploration into the utilization of such humour as a tool for more engaging science communication. The majority of the 76 respondents to an online survey were generally receptive to such use, with some differences between the two groups. It was also noted that a receptiveness to such humour may not necessarily be associated with a receptiveness to its actual use in science articles.

Keywords

Popularization of science and technology; Public engagement with science and technology; Science and media

DOI

https://doi.org/10.22323/2.20040206

Submitted: 17th January 2021
Accepted: 5th April 2021
Published: 5th July 2021

Introduction

Whether consciously or not, both science and non-science undergraduates are consumers of science and science information (e.g. medical, general health, technology). While their academic major may represent a certain proclivity towards science, it may not define their engagement with communicated science. For example, a science undergraduate may not actually read science news regularly and conversely, an arts undergraduate may be particularly interested in the latest information on, say, environmental science, perhaps due to the individual's pre-disposition towards, or exposure regarding, the specific issue [Brossard, 2013]. Later on, when either group transits to working life after their formal education, their contact with science, through exposure (e.g. from media) or more self-directed means (e.g. searching online for information), will not cease [Ryder, 2001], and they will continue to be consumers of science and science information.

According to Thomas and Durant [1987], an "improved understanding of science and technology is useful to anyone living in a scientifically and technologically

sophisticated society. The claim here is that more knowledgeable citizens are able to negotiate their way more effectively through the social world: that they are better-equipped to take decisions about diet, health-care, and personal safety; and that they are better-placed to make a wide range of consumer choices" [p. 5]. As science is ever evolving, and whether it is for economic, utility, democratic, social or cultural (historical) reasons as to why people should know something of science [Ryder, 2001], it is crucial that their understanding of science and technology does not stagnate, but be continually built upon and expanded. Hence, it is important to continually engage people with science information, and to help to keep them interested in science and/or its developments, during and beyond their formal education. This study aims to explore if humour, specifically positive, non-aggressive humour, can be a tool for such engagement with science and non-science undergraduates.

Humour

Traditionally, there are three theories of humour: the superiority theory, the incongruity theory, and the relief theory [Lintott, 2016]. The superiority theory asserts that people derive pleasure from feeling, or seeing themselves as being, superior to others [Cornett, 1986], the incongruity theory provides an explanation for humour resulting from unexpected or illogical connections, surprises or contradictions, i.e. incongruity [Banas et al., 2011; Cornett, 1986], and the relief theory focuses on humour and laughter, which releases built-up tension, energy and stress [Banas et al., 2011; Lintott, 2016]. One may see the superiority theory as emphasizing the social and emotional aspects (i.e. having an enjoyable feeling from making fun of others), the incongruity theory as focusing on the cognitive aspects (i.e. resolving an incongruity), and the relief theory as a physical response (i.e. laughing to release tension), and the experience of comic amusement may often involve some or all of these three aspects [Banas et al., 2011; Lintott, 2016].

Humour has often been recommended in science communication books for communicating science to the public [e.g. Baram-Tsabari and Lewenstein, 2017; Bowater and Yeoman, 2012], despite there being relatively little empirical evidence on its effectiveness [Yeo et al., 2020]. Such advice has its definite appeal, especially for science communicators who hope to use humour to make science communication events or texts more enjoyable and accessible, to enhance learning about scientific concepts, to increase positive attitudes towards science and scientists [Pinto and Riesch, 2017], and to improve the chances of getting the message across [Gross, 2015]. Hence, it is hardly surprising to find humour being used in different arenas of science communication.

Use of humour in public science communication

In recent years, there has been an increasing use of humour in public science communication, such as stand-up routines, science-based sitcoms, and other humourous science-related events or platforms [Pinto and Riesch, 2017; Riesch, 2015]. One notable example is 'Bright Club', a project, developed at University College London, which organizes stand-up performances by researchers, and which has also been initiated at several other United Kingdom universities [Bright Club, 2020; Riesch, 2015]. This project has provided a unique opportunity to engage audiences with science, and has been very successful in accessing young adult audiences (aged 20–40) outside of formal education, who are often

considered as being hard-to-reach through traditional methods [Bultitude, 2011]. In Portugal, a study on a stand-up comedy project by scientists found that such stand-up comedy on science was well-received by both the local scientific community as well as the audiences, and helped to dispel the stereotypical perception of science and scientists [Pinto, Marçal and Vaz, 2015].

Another well-known example is the popular American television sitcom, 'The Big Bang Theory', which has, in terms of contributing to science communication, brought science and scientists into the general public discussion [Riesch, 2015], provided an informal means of communicating to viewers, or teaching them about, the nature of science [Li and Orthia, 2016], explored popular scientist stereotypes [Weitekamp, 2017], and illustrated the potential for comedy to explore the meanings of science within culture [Bankes, 2016], etc.

Other examples where humour has been used in public science communication include webcomics (e.g. XKCD by Randall Munroe, PhD comics by Jorge Cham), science websites (e.g. Improbable Research), popular online media channels (e.g. Vsauce by Michael Stevens), etc. While there are many forms of science-based humour, there is still limited research into how humour can be effectively employed in the public understanding of science [Pinto, Marçal and Vaz, 2015; Riesch, 2015]. Asian studies in this field are even more rare, and this study hopes to contribute in this aspect.

Use of humour in education

There has been extensive research on the use of humour in education. Many scholars have advocated for its incorporation into the classroom [Banas et al., 2011], and for a variety of reasons. Humour can be used, for example, as a viable approach to reduce student anxiety about their course of study [Berk and Nanda, 1998], to enhance student self-esteem [Pollak and Freda, 1997], to break down the barriers to communication between teachers and their students and build rapport [Berk, 1996; Pollak and Freda, 1997], to foster mutual openness, respect and a sense of community [Kher, Molstad and Donahue, 1999], to aid student interest, attention, motivation, comprehension and retention [Kher, Molstad and Donahue, 1999; Lei, Cohen and Russler, 2010], to encourage risk-taking, assist in problem-solving and inspire creativity in students [Lei, Cohen and Russler, 2010], as well as to help correct reading problems, control behavioral disorders, build vocabulary and integrate social isolates [Cornett, 1986]. Indeed, as Lei, Cohen and Russler [2010] succinctly puts it, humour has many psychological, social and cognitive benefits when used in the classroom.

Numerous ideas and creative strategies have also been proposed as to how humour can be used [e.g. Berk and Nanda, 1998; Cornett, 1986; Kher, Molstad and Donahue, 1999], and Berk [1996] notes that "one does not have to possess the comedic gifts of a Jerry Seinfeld, Billy Crystal, or Ellen DeGeneres" [p. 87] to generate the humorous materials necessary, as these can be generic and adapted from any popular humour resources available. Furthermore, humour should be intentional, planned well and executed systematically into instruction to achieve desired, specific outcomes [Berk, 1996], and the incorporation of humour across all academic levels is encouraged [Torok, McMorris and Lin, 2004].

While the majority of research has focused on the positive outcomes of using humour in formal education, researchers have also pointed out that certain types of instructional humour may produce negative consequences [Banas et al., 2011]. Torok, McMorris and Lin [2004] list seven types of instructional humour that the researchers considered to be positive: funny stories, funny comments, jokes, professional humour, puns, cartoons and riddles, as well as four types they considered as negative: sarcasm, sexual humour, ethnic humour and aggressive/hostile humour. It is the use of negative humour that many researchers warn against [e.g. Cornett, 1986; Gorham and Christophel, 1990; Lei, Cohen and Russler, 2010; Wanzer et al., 2006]. Negative humour, such as that which degrades students' gender, ethnicity, nationality, religion, sexual orientation, intelligence, physical appearance, etc., must be discouraged in the classroom [Lei, Cohen and Russler, 2010]; offensive humour should never, under any circumstances, be used [Berk, 1996]. Not only can feelings be hurt [Cornett, 1986], when an individual or group is the target or subject of ridicule, attitudes towards the area of study can also be adversely affected [Gorham and Christophel, 1990; Kher, Molstad and Donahue, 1999].

Banas et al. [2011] noted how methodological and conceptual discrepancies and contradictions in instructional humour research have prevented definite conclusions about its use in education, and conducted a thorough review of more than 40 years of research. They found that the use of positive, non-aggressive humour was associated with a more conducive learning environment, a greater motivation to learn and a greater enjoyment of the course of study, while negative, aggressive humour had much the opposite effect; there was also considerable empirical evidence that the use of humour could help in student recall and learning.

Receptiveness to humour & Rasch models

The understanding and appreciation of humour is a complex process [Suls, 1983]. One's sense of humour is related to one's age and gender [Cornett, 1986]; what constitutes as a humourous stimulus also varies from person to person and so does one's taste in, preference for, or receptiveness to, certain types of humour [Bore and Reid, 2014; Cornett, 1986]. Furthermore, a person's receptiveness to certain types of humour may not necessarily imply an associated receptiveness to the use of such humour in science communication, e.g. science articles.

An individual's receptiveness to humour can be treated as a latent variable, trait or construct. Such a variable is one that cannot be directly observed, and some other examples include intelligence, ability, social class, depression, attitudes, opinions, satisfaction [Alagumalai and Curtis, 2005; De Battisti, Nicolini and Salini, 2010]. While commonly used in education research, e.g. for evaluating assessment reliability, student ability and student achievement, Rasch models have also been used in past studies to evaluate other latent variables or traits such as attitudes [e.g. Eland et al., 2016], opinions [e.g. González-de Paz et al., 2015], and customer satisfaction [e.g. De Battisti, Nicolini and Salini, 2010].

The Rasch family of models allow such latent traits of individuals to be quantified. All the Rasch models are based on the idea that an individual possesses a certain "measure" of the latent trait (called the person measure) that is independent of the instrument used. The Rasch models also provide another measure (called the item

measure) that indicates the level of the trait that an item is most suited to measure. Another useful feature of the Rasch models is that both person and item measures are expressed in the same units (called logits), allowing for easy comparison. In this study, the Partial Credit Rasch Model [see e.g. Bond and Fox, 2013], which is commonly employed and suitable for Likert scale surveys, will be used as part of the analysis pertaining to the participants' receptiveness to positive, non-aggressive humour (refer Methodology).

Building on prior research

Pinto and Riesch [2017] examined the receptiveness of audiences to positive and non-aggressive humour using two popular science articles on environmental issues which were written by one of the researchers, and published online at a Portuguese site of a magazine called "Visão". Based on the 159 readers (aged 18 to more than 65 years old) who participated in their online survey, they found that, while using humour in popular science articles is considered valuable for the majority of respondents, different degrees of receptiveness do exist, as the inclusion of humour can simultaneously attract, cause indifference in, or repel readers, and hence one should be cautious in its use.

This study, with adaptations made, is built on the work by Pinto and Riesch [2017]. The main aims, in the context of science communication, are: (1) to explore, the differences, if any, in the receptiveness to positive, non-aggressive humour being used in a science article, between science and non-science undergraduates from a Singapore university, (2) to gather insight as to whether such humour-based science articles can be used to better engage such groups of the public, both now and in the future, outside of formal education, and (3) to explore the use of the Partial Credit Rasch Model in investigating the relationship between the respondents' receptiveness to positive, non-aggressive humour and their receptiveness to its use in science articles.

Methodology

A total of 76 undergraduates from the science and arts faculties at a local university in Singapore took part in the study. Participation was strictly voluntary. From an invitation email/message, students were provided with a link to an online survey which comprised three parts: (1) a set of jokes, (2) a science article, and (3) a questionnaire on the article. The participants took an average of about 8 min to complete the entire survey.

For the first part, a set of 12 jokes that had been carefully selected from the internet [Coolfunnyquotes.com, 2020; FunnyShortJokes.com, 2019; Larkin, 2019; Short-funny.com, 2020; Unijokes.com, 2020] and deemed culturally appropriate were presented, and respondents were asked to rate the jokes as "not funny", "moderately funny", or "funny". The humour in these selected jokes were positive and non-aggressive. No jokes which contained any negative humour, i.e. disparaging, gross, obscene or aggressive humour [Fisher, 1997; Pinto and Riesch, 2017; Zillmann, 1983], were used. This first part of 12 jokes was designed to elicit participants' receptiveness to positive, non-aggressive humour in general.

Like Pinto and Riesch [2017], the written format to be tested was the popular science article, and so the second part of the survey was an original article written

by one of the researchers, a chemical engineer by training, for this study: "Salmon says, 'This season's best OOTD is… lobster!"' (which was about lobster shells being utilized to manufacture biodegradable plastic). The article was not created with the help of any professional comedians as the researchers wanted to simulate how a science communicator or scientist could create humour, and/or use what is available, in their communication work [Berk, 1996; Pinto and Riesch, 2017]. The content for the article was researched and adapted from various online resources [Holland, 2019; Steffen, 2019; TODAYonline, 2019; Whiting, 2018], and pitched at a level that any literate young adult could understand without the need for a strong or specific science background, while articulating a scientific issue (i.e. plastic pollution) that is a present-day problem. An online, non-print, format of the article was also used in this study as a form of simulation since, increasingly, people are more apt to find scientific information and follow such developments online [Brossard, 2013].

To prevent the humour from being distracting, or perceived as predictable or forced [Fisher, 1997; Pinto and Riesch, 2017], humour was not inserted repetitively within the article, but only added at the beginning and at the end of the article, using cartoons [Romanova, 2020; FS4K, 2014] related to the subject matter [Berk, 1996; Kaplan and Pascoe, 1977]. Similar to the set of 12 jokes used in the first part, the humour in these cartoons were positive and non-aggressive, and no negative humour was used.

Following this article was a set of 13 questions as the third and final part of the survey. The first eight were Likert scale questions, with a 5-point response scale ranging from 1 (completely disagree / highly disinterested / never) to 5 (completely agree / highly interested / all the time), and which focused on the satisfaction with the article, the importance of the science content/issues, the enjoyability of the humour [see Pinto and Riesch, 2017], the credibility of science in the article, the respondents' general interest in science as well as their frequency of reading science news. The question on credibility was included to seek some evidence as to whether humour used in such articles would diminish the credibility of the science [Kaltenbacher and Drews, 2020; Pinto and Riesch, 2017]. The next four questions sought demographic factors about the respondents (i.e. age, gender [as per Pinto and Riesch, 2017], most recent formal science education level before entering university, and current undergraduate faculty), and the final one was an open-ended question for any respondent comments [as per Pinto and Riesch, 2017]. Details of the questionnaire can be found in appendix A.

A pilot study with some existing undergraduates and science teachers was conducted prior to data collection to assess if the article and questionnaire were clear and easy enough to be understood [Pinto and Riesch, 2017], if there were any issues with the content, and if there were any technical difficulties associated with the survey being hosted online. The original set of 20 jokes was reduced to the final 12 to cut down on survey response time, and this final set included the ones which the respondents in the pilot study found to be most "not funny", "moderately funny" and "funny". A finalized version of the survey was uploaded, and data was then subsequently collected.

After data collection was completed, quantitative analysis was carried for Questions 1–12 of the questionnaire and descriptive statistical results were

obtained using MS Excel. In a similar manner to Pinto and Riesch [2017], the results for Questions 1–8 were accordingly divided into three categories: [disagree / disinterested / rarely] (1–2), [neither agree nor disagree / neither interested nor disinterested / occasionally] (3), and [agree / interested / frequently] (4–5). The independent samples t-test was also performed for the two participant groups' responses to these eight questions. (In this study, an alpha level of .05 was employed for all statistical tests.) The comments from Question 13 of the questionnaire were first read to ascertain if they were relevant to the study [O'Cathain and Thomas, 2004], and these were then compared against the six categories generated by Pinto and Riesch [2017].

Analysis using the Partial Credit Rasch Model was carried out using the set of 12 jokes, and a person measure value for the individual's receptiveness to positive, non-aggressive humour was obtained using WINSTEPS for all respondents. Rasch model analysis subjects a set of given data (i.e. participant responses) to probabilistic measurement [Neff and Rucynski, 2017], and ranks the respondents according to their likelihood of choosing a particular response (i.e. "not funny", "moderately funny", "funny" in this case), and transforms these responses, which are ordinal data, into a linear interval scale data [Boone, 2016; Petra and Aziz, 2020], i.e. person measure values, which, in this study, represent a degree of receptiveness to positive humour for each individual. Correlation analysis using MS Excel was performed between these person measure values and the responses to Questions 1–6.

Results

For this study, 38.2% ($n = 29$) of the respondents were men and 61.8% ($n = 47$) were women (see Table 1). Their ages ranged from 19 to 32 years, and the average age was 20.7 (SD = 2.0). 47.4% ($n = 36$) were science undergraduates and 52.6% ($n = 40$) were non-science undergraduates. For their most recent formal science education before entering the university, 94.4% of science students had taken GCE 'A' Level (or its equivalent) and 5.6% had taken GCE 'O' Level (or its equivalent), while that for non-science students were 72.5% and 27.5% respectively. In other words, in terms of formal science education, the majority of participants had taken GCE 'A' level Science before university, and all participants had studied science minimally at the GCE 'O' Level (or its equivalent), and hence would unlikely face issues understanding the science content covered in the article.

The results for appreciating the humour in the science article showed that the majority of both science and non-science participants liked reading the article,

Table 1. Demographics of respondents ($N = 76$).

	Science	*Non-science*
Gender		
Male	18 (50.0%)	11 (27.5%)
Female	18 (50.0%)	29 (72.5%)
Total	36	40
Most recent formal science education level before university		
GCE 'A' Level (or equivalent)	34 (94.4%)	29 (72.5%)
GCE 'O' Level (or equivalent)	2 (5.6%)	11 (27.5%)

Table 2. Receptiveness of science vs. non-science undergraduates to a science article with inserted humorous elements using a questionnaire with a 5-point Likert scale. (All figures for non-science participants are given in parenthesis.)

	Average, standard deviation for science and non-science participants, and p-value	*Receptiveness of science and non-science participants in %*		
		Agree	*Neither agree nor disagree*	*Disagree*
1. I liked reading this article.	4.1; SD = 0.6 (3.7; SD = 0.8) $t(74) = 2.6$, $p = .01^*$	88.9 (70.0)	11.1 (22.5)	0.0 (7.5)
2. I would like to read more articles like this in the future.	4.0; SD = 0.9 (3.6; SD = 0.9) $t(74) = 2.4$, $p = .02^*$	75.0 (60.0)	19.4 (25.0)	5.6 (15.0)
3. The scientific content in this article is not important.	2.0; SD = 0.9 (2.2; SD = 0.9) $t(74) = -0.9$, $p = .39$	5.6 (7.5)	16.7 (15.0)	77.8 (77.5)
4. In this article, humour makes science more appealing.	4.0; SD = 0.9 (3.8; SD = 0.9) $t(74) = 0.7$, $p = .49$	66.7 (75.0)	27.8 (12.5)	5.6 (12.5)
5. I would prefer if the article did not have humour.	2.4; SD = 1.0 (2.0; SD = 1.0) $t(74) = 1.7$, $p = .09$	13.9 (10.0)	33.3 (15.0)	52.8 (75.0)
6. In this article, humour makes science less credible.	2.4; SD = 1.1 (2.1; SD = 0.9) $t(74) = 1.6$, $p = .11$	22.2 (10.0)	19.4 (15.0)	58.3 (75.0)

* $p < .05$

indicated that they would like to read similar articles in the future, and felt that the scientific content covered in the article was important (see Table 2). The percentages of science participants were greater for these three aspects as compared to their non-science counterparts. The responses regarding the specific role of humour were also generally similar: the majority of both science and non-science participants felt that humour made the science more appealing, did not prefer that the article had no humour, and felt that humour did not make the science less credible. The percentages of science participants were smaller for these three aspects as compared to their non-science counterparts. A visual summary of these results (for Questions 1–8) is also provided in Figure 1.

There were significant differences found between the science and non-science groups for Questions 1 and 2, i.e. science undergraduates may enjoy reading such articles to a larger extent as compared to non-science undergraduates, even though both were favorable towards such articles.

In terms of the respondents' general interest in science, the majority of both science and non-science undergraduates reported being interested in science (see Table 3). The data shows a significant difference between the two groups.

In terms of the respondents' frequency in reading science news, the majority of science undergraduates reported reading science news occasionally or more, while the majority of non-science undergraduates reported reading science news occasionally or less (see Table 4). The data shows a significant difference between the two groups.

Figure 1. Visual summary of results for Questions 1–8.

Analysis using the Partial Credit Rasch Model was carried out based on the participants' responses to the set of 12 jokes (i.e. test-items), and the following Wright map (see Figure 2) for all 76 participants was obtained. A set of person

Table 3. Respondents' reported interest in science based on question with a 5-point Likert scale. (All figures for non-science participants are given in parenthesis.)

	Average, standard deviation for science and non-science participants, and p-value	*Interest in science for science and non-science participants in %*		
		Interested	*Neither interested nor disinterested*	*Disinterested*
7. How would you describe your interest in science?	4.5; SD = 0.7 (3.6; SD = 0.9) $t(74) = 4.8$, $p < .001$	91.7 (60.0)	5.6 (27.5)	2.8 (12.5)

Table 4. Respondents' reported frequency of reading science news based on question with a 5-point Likert scale. (All figures for non-science participants are given in parenthesis.)

	Average, standard deviation for science and non-science participants, and p-value	*Interest in science for science and non-science participants in %*		
		Frequently	*Occasionally*	*Rarely*
8. How often do you read science news?	3.7; SD = 0.8 (2.3; SD = 0.9) $t(74) = 4.8$, $p < .001$	61.1 (7.5)	30.6 (32.5)	8.3 (60.0)

measure values representing the individual's relative receptiveness to positive humour (based on the 12 jokes) was obtained for each respondent, and for example, R44 (2.01) was more receptive than R22 (−0.72) who was more receptive than R55 (−2.47).

Person reliability was 0.76 and item reliability was 0.85. The closeness of the mean item measure ("M" on the right) and the mean person measure ("M" on the left) also indicated that the range of jokes presented to the respondents was appropriate to them [Boone, 2016]. No trend in terms of either gender or academic discipline was observed.

While there were no respondents who found all 12 jokes to be "funny", there were three respondents, R08, R29 and R32, who found all 12 jokes to be "not funny". As the Rasch model is not able to further separate or distinguish between these respondents, i.e. being of extreme values, their data was removed from the subsequent part of the analysis.

A recalculated value for the person measure, i.e. receptiveness to positive, non-aggressive humour, was obtained for the remaining 73 participants, and these ranged from −3.21 to 2.00. Correlation analysis was carried out between these person measure values and the corresponding participants' responses to Questions 1–6. Weak to negligible correlation [Schober, Boer and Schwarte, 2018] was found between the receptiveness value and these six questions (see Table 5).

For the open-ended question (Question 13), there were only a handful of comments that were relevant and related to the study (6/76). These were approximately matched with three of the six emergent categories as given by Pinto and Riesch [2017]: importance of humour (1 comment), humour in science communication (3 comments), and humour in popular science articles (2 comments).

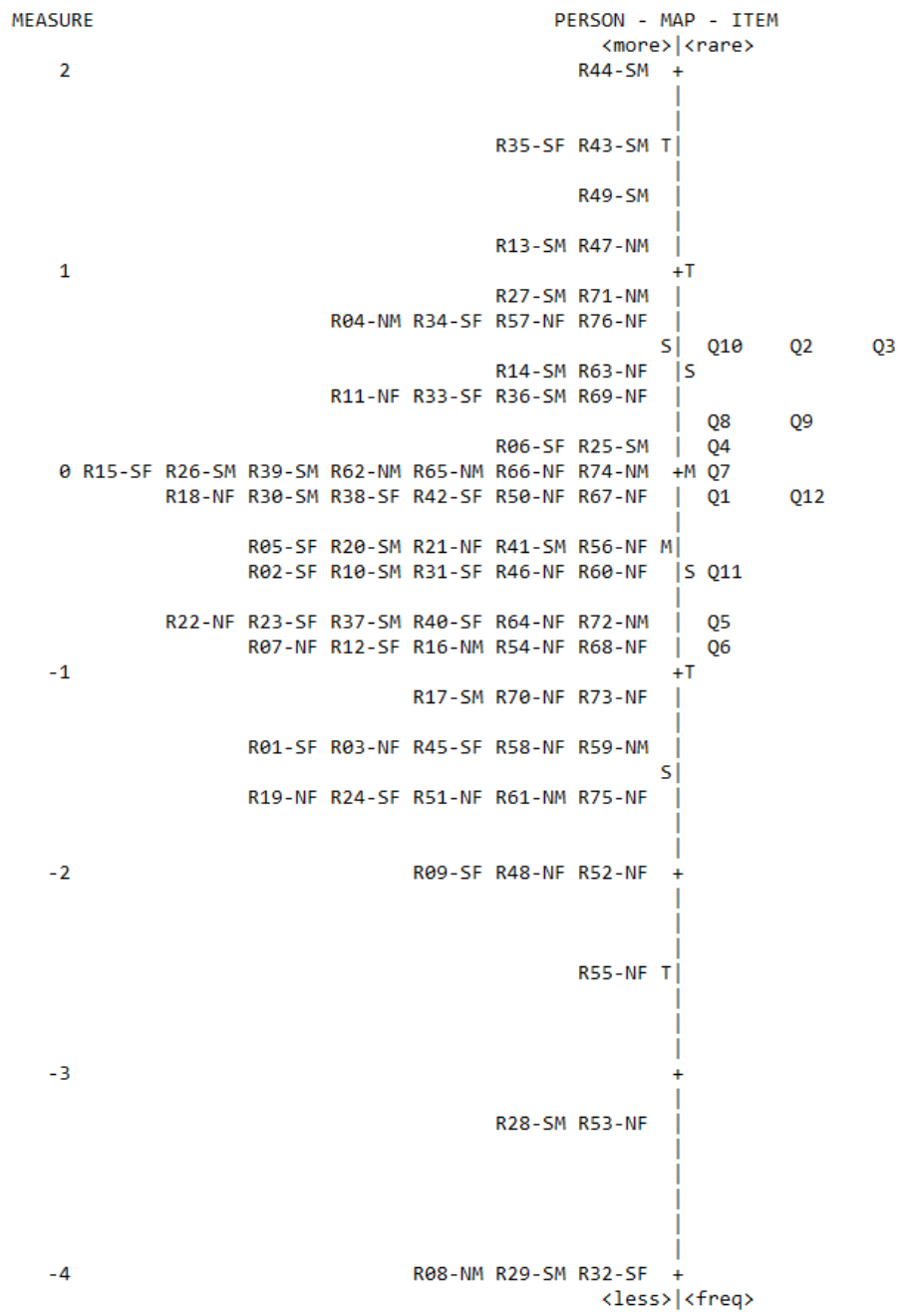

Figure 2. Wright map from using the Partial Credit Rasch Model on set of 12 jokes (e.g. SF = Science Female; NM = Non-Science Male).

Discussion

This study took reference from the work of Pinto and Riesch [2017], and examined the differences in the receptiveness to positive, non-aggressive humour being used in a science article, between science and non-science undergraduates, who are consumers of science and science information, so as to explore the potential use of such humour in the engagement of these publics.

As Pinto and Riesch [2017] highlighted, the use of humour in the communication of science can have varying results and limitations [see e.g. Bore and Reid, 2014; Weitkamp and Burnet, 2007]. This current study also provides evidence which corroborates this view.

Table 5. Correlation data for receptiveness value and Questions 1–6.

Comparison with receptiveness value	*Correlation*	
Q1	$R = 0.278$	$p = .017^*$
Q2	$R = 0.288$	$p = .013^*$
Q3	$R = 0.000$	$p = .998$
Q4	$R = 0.380$	$p = .001^*$
Q5	$R = -0.187$	$p = .112$
Q6	$R = -0.087$	$p = .463$

* $p < .05$

In their study, Pinto and Riesch [2017] found that more than 80% of their respondents enjoyed reading the science articles inserted with humour, indicated that they would like to read more of such articles in the future, and felt that the scientific issues covered in the articles were important. The current study found that, regardless whether they were science or non-science undergraduates, the majority of the participants responded in the same way as Pinto and Riesch [2017] in these areas, although non-science undergraduates may be enthusiastic to a lower extent.

Pinto and Riesch [2017] also found that about 65% of their participants felt that humour made the science more appealing, and a similar 63.5% preferred the use of using humour in the science articles. In the current study, the responses were more divided for the two groups surveyed. 66.7% of science undergraduates felt humour made the science more appealing, but only 52.8% preferred the inclusion of humour. These results were both lower than the respective 75.00% and 75.00% for non-science undergraduates. In other words, compared to science undergraduates, non-science undergraduates may generally be more receptive to the inclusion of humour in science articles.

A possible reason for this could be the perception of science undergraduates regarding the appropriateness of the use of humour in different communication formats that represent their discipline. While not representative, the following comment from one science undergraduate may provide some insight: "The humor is intended for articles published in popular science magazines, not for proper research articles though! It's a great way to bring in people to read an article instead of a boring abstract". In other words, science undergraduates may have greater reservations in endorsing humour for general use, i.e. humour should not be used broadly across all science publications.

In terms of the perception of credibility being affected by humour, the majority of both groups did not feel that humour made the science less credible. The placement and (limited) extent to which the humour was included could also have contributed to such positive responses by both groups. As one science undergraduate commented: "I felt that the article itself does not have too much humour, just the ones at the beginning and the end, so did not affect the credibility".

However, it should also be noted that a greater proportion (75.0%) of non-science undergraduates disagreed that humour made the science less credible as compared

to their science counterparts (58.3%). There was also a larger proportion of science undergraduates (22.2%) who felt humour made science less credible as compared to their non-science counterparts (10.0%). These disparities could perhaps stem from science students (i.e. the science community) being more concerned about the accuracy of scientific information being affected by the use of humour.

Besides credibility, a related issue or risk that some authors have surfaced is that certain humour, e.g. satirical humour, may encourage members of an audience to discount or trivialize the seriousness of a particular issue (e.g. climate change) instead of adopting a more critical perspective of, or a more active engagement with, the issue in question [e.g. Becker and Anderson, 2019; Bore and Reid, 2014; Pinto and Riesch, 2017]. Hence, science communicators should be mindful of the extent to which humour is included in what they present, and carefully negotiate between what could be deemed as the realm of humour and that of serious discourse [Bore and Reid, 2014].

The results for the respondents' reported interest in science and their frequency of reading science news were generally not unexpected, and significant differences between the two groups found for both these areas indicated that their academic discipline did correctly distinguish between the participants. It was also encouraging to see that a good majority of non-science undergraduates (60.0%) reported an interest in science, which bodes positively for a science communicator wanting to engage this public.

In this study, a set of 12 jokes was employed as test-items under Rasch analysis to obtain a person measure value as an indicator of each participant's receptiveness to positive, non-aggressive humour. The data obtained did not provide strong evidence to show that one's receptiveness to such humour was associated with one's receptiveness to the overall use of such humour in science articles based on the six questions posed. This is important in the sense that even if a science communicator is planning to employ jokes that a particular audience may enjoy, it may not necessarily translate into any greater acceptance or receptiveness when such humour is actually used in the science communication text. In other words, just because a public may be partial to certain types of jokes, a communicator should not assume that when such jokes are actually employed in a science communication context, the public's response would necessarily be more favorable.

That being said, perhaps more can be gleaned from further study by examining the *appropriateness* of a particular joke with respect to the context it is to be employed, as well as its actual *placement* in an executed communication. As one respondent puts it, "whether the joke was pulled off well will determine whether the article would benefit from the humour. A distasteful or poor joke puts me off the article slightly whereas a well-timed joke just as the content may be getting slightly dry perks my interest to sustain the reading".

Conclusion

Apart from the relatively small sample size and hence possibly a lower generalizability of the findings, one limitation of this study was that unlike the real online magazine in which Pinto and Riesch [2017] published their science articles, this study's article used could only simulate what could be found online in terms of science websites, blogs, etc. While actual readers of the magazine would provide

a better representation of their perception to the use of humour, it could also mean that it could be somewhat "preaching to the choir", as the readers would already have an interest in reading the science articles published by the magazine. It was the intention of the study to explore if humour could be used to appeal to publics who may already not have strong interests in science, or read science news infrequently.

This study provides some evidence that while the majority of respondents were accepting of the use of positive, non-aggressive humour in science articles, such use could be better received by non-science undergraduates. As mentioned earlier, this latter group reported a good interest in science, and although they may read science news infrequently, they are open to the use of positive humour in science articles, and so this may be a viable method to engage such a public. As for their science counterparts, they are already interested in science and frequently read science news, and while they are open to the inclusion of humour, they may also be more concerned with the credibility of science being affected.

Different authors have also advised on the need to carefully consider the humour preferences of an audience when using humour in science communication, as these could be dependent on a wide range of factors, including culture, context, gender, age, education level, political afflictions, etc. [e.g. Bore and Reid, 2014; Cornett, 1986; Pinto and Riesch, 2017]. While it is not possible to please everyone, a science communicator reaching out to either group, or a mixed audience of both groups, could do well to consider these preferences, carry out research on the type of jokes that may appeal to the audience, insert humour appropriately and not excessively, so as to lower the possibility of affecting the credibility, or seriousness, of the science that is being presented, and yet attempt to reduce the "distance" between the general public and science. That being said, while it would be wise and practical to research into the type of jokes that the audience may fancy, it does not mean that a receptiveness to a certain type of humour is necessarily associated with a receptiveness to its actual use in science communication. It is a delicate balance to juggle, but the inclusion of positive humour in science articles may be a step in the right direction for better public engagement.

Appendix A. Questions used in current study

Q1. I liked reading this article.
Q2. I would like to read more articles like this in the future.
Q3. The scientific content in this article is *not* important.
Q4. In this article, humour makes science more appealing.
Q5. I would prefer if the article did not have humour.
Q6. In this article, humour makes science less credible.
Q7. How would you describe your interest in science?
Q8. How often do you read science news?
Q9. Age
Q10. Gender
Q11. Most recent formal science education level before entering university
Q12. Current undergraduate faculty
Q13. Comments (Optional)

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How to cite

Chan, A. and Udalagama, C. (2021). 'Exploring the use of positive humour as a tool in science communication: do science and non-science undergraduates differ in their receptiveness to humour in popular science articles?'. *JCOM* 20 (04), A06. https://doi.org/10.22323/2.20040206.

ISSN 1824-2049. Published by SISSA Medialab. jcom.sissa.it