Anthropomorphism: Metaphor or misconception?

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Contents

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Anthropomorphism: Metaphor or misconception?

Anthropomorphism is the attribution of human characteristics to non-human things. It is an automatic part of human reasoning and language, and changes the way we perceive and interact with the world around us. It has a complex relationship with science, usually being perceived as not scientific. Despite this, it has found a role in education as a metaphor and communication technique. With increased awareness, I propose it may be a useful technique in science communication as well.

Keywords: Anthropomorphism, Science education, Science communication

Introduction

The human tendency to anthropomorphise, to "attribute human characteristics to non-human things or events" (Guthrie, 1997, p. 51), has come to play a key role in science, its education, and its communication. Each of these fields sees anthropomorphism differently. In science, especially biology, anthropomorphism is dogmatically rejected (see Wynne, 2004), whereas those involved in science education are more accepting, seeing it as situationally useful (see Zohar & Ginossar, 1998).

There is comparatively little research into the role of anthropomorphism in science communication Establishing its role in how science is communicated to non-expert audiences, and how that fits in with the scientific and educational literature, is a crucial first step in arriving at a set of best practices around its use as a science communication technique.

In this review, I will establish how anthropomorphism works in human thought and language. I will explore how the phenomenon is viewed in scientific literature, considering the concerns of scientists and the potential misconceptions that might arise from its use. I will also examine the literature from science education and science communication, to explore common themes and strategic uses of anthropomorphism in

context. Finally, I will present some recommendations for practitioners and future researchers.

Purpose

Although some individual studies exist, there is no consensus on the role of anthropomorphism in science communication. This review draws upon material from psychology, science, science education and science communication, to investigate the following research questions:

(1) How does anthropomorphism work?
(2) How is anthropomorphism viewed?
(3) How, if at all, should it be used?
(4) Where should further research be directed?

I aim to provide a basis for informed discussion by scientists and science communication theorists on the strengths and weaknesses of anthropomorphism as a science communication technique. I also aim to provide some practical guidance for science communication practitioners, including science writers and journalists covering science. Finally, I hope to provide some insight into possible directions for future research.

Methodology

I used a hybrid of systematic keyword searching (see Table 1 for a list of terms) followed by snowballing (see Wohlin, 2014). I identified papers for inclusion during both stages, based on title and abstract screening, and identification of key references. I chose 52 papers to read in detail across the fields of psychology (4), linguistics (5), science & philosophy of science (11), education (14), and science communication (8). I

identified 19 of these as highly cited key references in their field. I used both forwards and backwards snowballing – that is, both earlier papers cited by my key reference, and later papers citing it (as identified by Google Scholar).

Selection criteria were based roughly on the extent to which I felt the paper would answer my research questions (see above). I required the literature to be in English, with the full text available either online or as a hard copy from the University of Western Australia library. Four papers were excluded, either because the full text was not available or because they were not published in a sufficiently reputable publication.

I analysed the literature from broader fields (detailed in the Background section, below) to establish themes for a more critical evaluation of the literature from the more specific fields of science communication and science education (see Results, below).

Table 1: Search terms

Research gap	
Anthropomorphism	"Popular Science"
Anthropomorphism	"Science Writing"
Anthropomorphism	"Science Communication"
Anthropomorphism	"Science Journalism"
Anthropomorphism	"Science Education"
Context	
Anthropomorphism	Science
Anthropomorphism	Learning

Anthropomorphism	Education
Anthropomorphism	Psychology
Anthropomorphism	Ecology
Anthropomorphism	“Animal Welfare”
Anthropomorphism	Writing
Theory	
Anthropomorphism	Memory
Anthropomorphism	Understanding
Anthropomorphism	Retention
Anthropomorphism	Attitudes
Anthropomorphism	Learning

Background

Psychology

Anthropomorphism is regarded as a natural and automatic part of human cognition (Guthrie, 1997).

The key works on the psychological basis of anthropomorphism come from Epley, Waytz & Cacioppo (2008; 2007; 2010). They propose a three-factor theory of anthropomorphism, discussing both what causes it, and its effects on thought.

Causes

Epley et al characterise anthropomorphism as a process of elicited knowledge. They hypothesise that anthropomorphic understandings of the world are triggered when an object looks or acts particularly human, or when no other suitable knowledge is available. Anthropomorphism is our default, based on our always-available knowledge of human subjective experience. If other understandings of the event or object are available, this default will be corrected.

Epley et al propose two emotional factors which change how likely we are to anthropomorphise. The first is sociality motivation, which suggests we anthropomorphise more when we desire social contact with others. The second is effectance motivation, which suggests we anthropomorphise to reduce uncertainty and feel in control of our surroundings.

Effects

The effects of anthropomorphism roughly correspond to its causes. Anthropomorphism improves our confidence and sense of control in unfamiliar situations, and gives us a sense of social connectedness. It also changes the way we conceptualise the object or event we're anthropomorphising. We see it as more human: it is responsible for its own actions, worthy of moral consideration and empathy, and perceived as a source of social influence.

The strength of anthropomorphic beliefs varies, from strongly-held beliefs where an object is literally seen, described and treated as if it were human, to weaker 'as if' beliefs (Epley et al., 2007, p. 867) which are understood, consciously or unconsciously, to be a metaphor. Epley et al contend, however, that this is a difference in strength rather than a difference in type (2007, p. 867).

Utility

This theory is useful for several reasons. It has been empirically tested, both by the authors (Waytz et al., 2010) and others (e.g., Tam, Lee, & Chao, 2013). It is highly cited and widely accepted across different fields, demonstrating interdisciplinary applicability. It makes clear predictions about the causes and effects of anthropomorphism, which I will use to more effectively interrogate the science education and science communication literature.

Language

Anthropomorphism is not just built into the way we think, it is also built into the way our languages work. Even rigorous scientific discourse uses these patterns frequently Master (1991) points out a simple example of this, seen in phrases like 'the thermometer measures…'. Master writes that "...we are fully aware that it takes a human to use a thermometer, […] but we invest the instrumental subject with the power to act in a human way, that is , we anthropomorphise it, but in a restricted manner." (Master, 1991, p. 18).

This pattern extends to components of the scientific literature itself. Schoenfield (1981) notes that scientific papers often refer to 'data demonstrating' and 'tables indicating', pointing out that "Data, results, curve shapes, rates of increase, and so on can far more readily be imagined as participants in an argument…" (Schoenfeld, 1981, p. 183)

Sealey and Oakley (2013) identify further patterns of anthropomorphic language in David Attenborough's series *Life*. Gendered pronouns invite audiences to identify with the animals' experiences, and the preposition 'to' is used to imply planning and intentionality. These anthropomorphic patterns occur even in spoken language, and

even where the speaker is particularly sensitive to avoiding them: Attenborough is cited as regarding anthropomorphism as "the greatest perversion of a zoologist" (León, 1998).

In this case, anthropomorphism also serves to enable the use of narrative. Narratives are a popular and powerful way to communicate, but they generally require characters (Dahlstrom & Ho, 2012). In a story lacking a human protagonist, anthropomorphism is one way to fill this narrative role (León, 1998). Indeed, Sealey and Oakley identify frequent ‘micro-narratives’ throughout Attenborough’s narration which are seemingly enabled through this anthropomorphic language.

Anthropomorphism is used consciously and unconsciously, verbally and in written materials, even in formal scientific contexts. The breadth and ubiquity of this pattern demonstrates that anthropomorphism is inevitable. Whether we like it or not, this pattern permeates not just the way we think but the way we communicate and tell stories.

Science

Anthropomorphism and science have a complex relationship. In most fields of science, anthropomorphism is viewed as 'not scientific' (Wynne, 2007), with biologists (and animal biologists in particular) generally having the strongest views.

The scientific literature has explored the effects of anthropomorphic reasoning in some detail, largely in the form of positional papers. This literature attempts to identify some of the key misconceptions that might arise when anthropomorphism is used in science. It also serves as a proxy for the concerns, justified or otherwise, that scientists have about anthropomorphism.

Misconceptions & Concerns

I identified three broad themes in the scientific literature: concerns about causality, concerns about falsifiability, and concerns about simplicity.

Causality. Science attempts to explain the natural world, and a scientific explanation generally requires some exploration of causes (Lipton, 2001). Hanke (2004) argues that anthropomorphic explanations are often teleological. By implying that something has a mind and a subjective experience of the world, we assume that it, like us, has plans for its future, and that like us, it acts the way it does because of those plans.

For example, in describing a gene as 'selfish', Sullivan (1995) points out that genes are ascribed the human desire of self-interest as the 'reason' for the way they work, obscuring the true processes of differential survival at work in evolution.

Rather than describing actual causes, Hanke claims, anthropomorphic explanations substitute a *need* or *desire* to achieve the effect. This kind of explanation often appears satisfying, but has ultimately obscured the true causes at work.

Falsifiability. A crucial principle of modern science is that all parts of science should be falsifiable (Popper, 2002).

Concerns about the falsifiability of anthropomorphic hypotheses have come primarily from the field of biology, and specifically animal behaviour, where the subjects of study are perceived as more likely to have subjective experiences of their own.

Davies (2010) highlights several specific experimental cases in biology where he believes anthropomorphic hypotheses have misdirected entire lines scientific enquiry, and demonstrates some of the absurdities (such as the idea of 'microbe rights') that these kinds of untestable hypotheses can generate.

Millikan (1997) posits that while animals may have a subjective experience of the world, ideas about the internal representational systems of animals are ultimately speculative. Wynne (2007) points out that such speculations are not testable, as it is not possible to observe the subjective experience of animals. Any hypotheses based on speculations about subjective experience, and any conclusions they lead to, cannot be considered scientifically valid.

Simplicity. The common scientific heuristic Occam's Razor states that "in explaining a thing no more assumptions should be made than are necessary" (OED, 2017). Anthropomorphic reasoning often violates this, the literature suggests, implying the existence of unnecessary entities. Again, these concerns come principally from biology, this time from evolutionary biology, and stem from concerns about understandings of natural selection.

Guthrie (1997) characterises anthropomorphism as 'overfitting' in the otherwise useful cognitive process of trying to figure out another human's actions and intentions. This, he claims, leads us to see intentional entities where none exist. While this is related to the concerns about causality discussed above, in this case it is the generation of the entities to have the intentions that is the issue.

This is particularly salient in discussions of evolution, where the main competing argument is creationism. Hanke (2004) points out that popular explanations of natural selection position nature as an active agent, selecting based on some mysterious criteria of 'fitness'. Hanke argues that this just shifts agency from a supreme being to an anthropomorphic version of 'nature', when in fact there is no agency involved anywhere in the process - and indeed, the absence of that active entity is the key distinction between the competing explanations.

Objectives

In science, anthropomorphism is viewed primarily as a way of thinking, as a method of hypothesis generation. It is (rightly) perceived as being an incorrect understanding of the way the world actually works.

Science education and science communication have different goals. The science education literature acknowledges that 'students science' is distinct from 'scientists' science', noting that "'standard science education' differs considerably in philosophy, method and process from science itself." (Watts & Bentley, 1994), aiming to foster understanding scaffold future learning rather than allow academic rigour. Science communication, meanwhile, is often concerned with increasing awareness, engagement, confidence and attitudinal or behaviour change for non-expert audiences (Burns, O'Connor, & Stocklmayer, 2003).

While science communication may not aim to allow its audience to make robust scientific hypotheses, the ideas being communicated must at the very least be correct and not contradictory to the actual science.

The concerns outlined in the scientific literature, such as the issues raised around natural selection above, help to identify where anthropomorphic explanation contradicts the idea being communicated. They illustrate the fields and ideas where misconceptions are most likely, where anthropomorphism must be used carefully, and where efforts to avoid it must be targeted.

It perhaps also suggests by omission that there are some areas where it is not such a problem. While anthropomorphism undeniably produces bad hypotheses, its unique cognitive properties may make it much more suitable when engaging non-scientists with science.

Results

Science education

While the primary purpose of this review is to explore anthropomorphism in science communication, there was limited science communication-specific literature available. As such, I also included material from the related but distinct field of science education, which explored the topic in much greater breadth and depth.

Science education shares several goals with science communication. Both deal with audiences who are being introduced to a topic for the first time, and who are unlikely to have any alternative knowledge structures available to them (Epley et al., 2007). They generally need to keep those audiences engaged over any requirements for scientific rigour (Burns et al., 2003; Watts & Bentley, 1994).

Table 2: Science education literature

Paper	Methodology	Sample size	Age	Language	Conclusion
Coll & Treagust, (2002)	Interviews	6	Grade 12-university	English	Minimal discussion of anthropomorphism - "aids explanation" only.
Friedler, Zohar & Tamir (1993)	Tests	168	Grade 10 - university		Age and study (esp. of biology) makes students less likely to anthropomorphise
Jungwirth, (1977)	Tests	208	Teachers, scientists, education theorists	Hebrew	Experienced teachers and education theorists rejected anthropomorphic explanations as wrong, scientists and inexperienced teachers less so.
Kallery & Psillos, (2004)	Interviews	10	Teachers	Greek	Generally, causes confusion and incorrect conceptions, very occasionally

					justified - but used anyway, often unconsciously
Taber & Watts, (1996)	Interviews	??	16yo	English	Useful (for engagement, communication) when weak, problematic when strong.
Taber, Trafford & Quail, (2006)	Classroom observations	2	Teachers	English	Useful as a first step or introduction, analogical nature should be made explicit. 'Way of thinking about', not a 'way of explaining'. Teachers aware of limitations of analogy
Tamir & Zohar, (1991)	Interviews	28	15-17yo	English, Hebrew	Used frequently, not objected to, perceived as easy to understand, obviously a metaphor, but possibly also confusing. Formulations don't imply reasoning.
Zohar & Ginossar, (1998)	Position paper (references several other studies)	n/a	n/a	n/a	Appears to have no significant ill effects when used as a heuristic or communication technique, and may actually be useful. Suggests teachers bring it up, and flag it, so it can be corrected/used.

This selection represented a variety of positions, methodological approaches, and sample groups. Notably, the variety of approaches in science education was much greater than seen in science communication (see below). Much of the work is either

conducted by or based upon the efforts of two key groups of collaborators: Watts & Taber, based in the UK, and Tamir & Zohar, based in Israel.

Common themes

While still being viewed critically, anthropomorphism is more accepted in the science education literature than in the scientific literature. Concerns mirror those in the scientific community, focused on causality and teleology. Subject matter is broader than in science, ranging across biology (Zohar & Ginossar, 1998), chemistry (Taber & Watts, 1996) and physics (Taber et al., 2006).

One trend which emerges is the idea that anthropomorphism is acceptable as an introductory (Taber et al., 2006) or communicative (Coll & Treagust, 2002) metaphor, but not as an explanation – as "a way to *start thinking about*, and not an acceptable *way of explaining* what is going on…" (Taber et al., 2006, p. 159)(emphasis from original). When asked directly, students are almost universally able to identify their 'weak' 'as if reasoning' (Epley et al., 2007, p. 867), but concede that it is a useful way of talking or thinking about a topic (Taber et al., 2006; Taber & Watts, 1996; Tamir & Zohar, 1991; Zohar & Ginossar, 1998).

Strategic use

From the other end, there are frequent calls for teachers not to discard anthropomorphic reasoning entirely, but instead to explicitly recognise its metaphorical nature (Taber et al., 2006), discuss the strengths and weaknesses of that metaphor with students (Zohar & Ginossar, 1998). It is identified as a way to introduce a new topic (Taber et al., 2006), increase engagement (Taber & Watts, 1996), and as a heuristic or shorthand during discussion (Zohar & Ginossar, 1998), but again, not as an appropriate method of explanation.

There is some evidence to support the idea that increased exposure to and experience with anthropomorphism increases ability to identify and correct it. This seems to hold for both students (Friedler et al., 1993) and educators (Jungwirth, 1977). Interestingly, while experienced teachers and education theorists were able to identify and correct anthropomorphic formulations, trained but inexperienced teachers and working scientists were less so. (Jungwirth, 1977; Kallery & Psillos, 2004). Furthermore, students of biology, where anthropomorphism is a more contentious and frequently discussed issue, were more readily able to identify and correct such formulations. This suggests that being conscious of anthropomorphism, and being able to correct it when necessary, requires practise and not just theoretical familiarity.

Anthropomorphism in the science education literature appears to be seen as a tool, no more or less misleading than any other teaching technique. There is a strong focus on recognising its strengths and weaknesses, often tested using direct observations of student and teacher behaviour. There is also a strong focus on making such teaching techniques explicit to their audiences, and some evidence that doing so increases ability to recognise and correct it. There may be some publication bias present here; there is often an explicit or implicit acknowledgement that this view of anthropomorphism is 'heretical' or 'taboo' (Zohar & Ginossar, 1998, title), and that perhaps these views or techniques do not match up with mainstream teaching practices. Even among perhaps more orthodox views, however, there is a recognition that anthropomorphism is ubiquitous (Kallery & Psillos, 2004). The ability to recognise it and make it explicit, if not use it, is seen as crucial to the effective teaching of science.

Science communication

Table 3: Science Communication literature

Paper	Methodology & Sample group (if applicable)	Conclusion
Adcroft (2011)	Textual analysis	Emphasises dramatic role - animals become characters in 'nature drama' Highlights potential to create empathy Ideas of causality, internal states, 'scientificness' are secondary to conservation goals
Leane (2007)	Textual analysis	Makes distinction between strategic and unavoidable anthropomorphism Electrons 'knowing'/'making decisions' is characterised as unlikely to activate incorrect implications because they're explicit and obvious, but serves to illustrate how strange quantum phenomena are. Ideas about consciousness/observation being ‘required by the universe’ on the other hand, can be problematic because it implies the existence of holistic cosmic entities and a one-ness with a conscious universe where in fact no such thing exists.

Legare (2013)	Interviews 98 school age children	Anthropomorphic narrative impeded evolutionary understanding, seen instead in terms of needs/desires/design-based Age has some effects on recall of details. Acknowledges temptation to use it as engagement
Mignone et al (2016)	Case study/Evaluation	Enormously successful. Clearly flagged as a metaphor – cartoons. Non-anthropomorphic interpretation provided in other channels. Potential misconception areas weren't the key messages of the piece. 'Motivations' of the spacecraft are easily transferrable to the motivations of the operators/researchers/team None of this is recognised in the paper
Pramling & Saljo (2007)	Textual analysis 40 articles, in Swedish	Makes distinction between deliberate and conventionalised metaphor Genes referred to as 'having knowledge,' 'making decisions,' 'deciding destiny', Components of cells referred to by their purpose rather than their causes mRNA as a character in a story, referred to by role

Sealey & Oakley (2013)	Textual analysis 30 000 words of transcripts from LIFE (TV series)	Documentaries use language - grammar, vocab, music, etc - to imply personhood. Focuses mostly on pronoun usage – he & she invites audience to identify and empathise Building 'mini-narratives' in text, with animals as characters Also focuses on connectives 'so' and 'which', implying teleological reasoning and suggesting intention.
Tam et al (2013)	Production tasks & surveys Groups of 20-50 students	Prevalent in environmental discourse, perhaps already considered useful in that context. Anthropomorphism increased ability to empathise & "connect to nature", leading to more conservation behaviour Nature/the earth “becomes worthy of moral consideration" "increases efficacy" - people feel like they can engage with it more.

Turney (2005)	Textual analysis	Current metaphors for discussing genetics are becoming less useful Perhaps an anthropomorphic one - genes as committees - can fill the niche? Models complexity and dynamic nature, pooling 'knowledge' and making 'decisions. Example of using anthropomorphic metaphors to their strengths

The literature in science communication is skewed heavily towards textual analysis, with relatively few studies on human subjects. This immediately suggests avenues for future research: while these hypotheses may be consistent with theory and informed by results from other fields, they remain largely untested and unverified within the context and goals of science communication.

Common themes

While science communication still has strong emphasis on animal biology, especially around discussion of misconceptions, the literature also includes physics (Leane, 2007), genetics (Pramling & Säljö, 2007) and space exploration (Mignone et al., 2016)

Science communication shares many of the same concerns and findings as the science education literature. In one of the few human studies, Legare et al. (2013) find that the pattern of older, more experienced audiences being more able to correct the misconceptions associated with anthropomorphism holds in informal settings, though this has yet to be tested with adults.

Several sources also make the distinction between strong and weak anthropomorphism. It is often conflated with ideas about explicitness and authorial intent, variously referred to as 'strategic' versus 'unavoidable', (Leane, 2007, Chapter 4) and 'deliberate' versus 'conventionalised' (2007). These characterisations have a stronger emphasis on purpose (using anthropomorphism to further the communicator's goals) than science education, which mostly focuses on function. This may be representative of the wider variety of end goals towards which science communication is directed (Burns et al., 2003).

Science communication shared many of the same concerns about accuracy as science, with less of a focus on teleology than in science education. This may be informed by the greater diversity in subject matter seen in the science communication literature – for example, Leane (2007) found that popular depictions of a quantum-mechanical universe suggested the existence of a large-scale consciousness in the cosmos in much the same way that descriptions of 'nature selecting' did. This illustrates that these issues are not as specific to evolutionary biology as the scientific literature would suggest.

Strategic use

The literature also identifies see some situations where the effects of anthropomorphism aligned with the goals of communication, albeit often unintentionally.

Several sources explored the uses of anthropomorphism in conservation. These used anthropomorphic representations of specific animals (Adcroft, 2011) or of nature as a whole. Tam et al (2013) were able to develop their audience's sense of empathy for the abstract idea of nature, consistent with the ideas of sociality motivation outlined by Epley et al. (2007). They also found audiences felt a stronger sense of efficacy around environmental issues, leading to increased conservation behaviour.

This demonstrates experimentally that the predictions made in the psychological literature hold for science communication. It also illustrates that strategic, controlled application of anthropomorphism can be used to further scientific goals, rather than just causing misconceptions.

Mignone et al. (2016) reported another such strategic application, albeit with little discussion of the mechanisms or implications of anthropomorphism. The anthropomorphic cartoons produced for the European Space Agency's *Rosetta* mission were a huge success, attracting over 1.8 million views across the video series (Mignone et al., 2016, p. 16). The media drew on both appearance and behaviour to appear human, and their cartoon appearance made it clear that the representation was a metaphor.

The key messages of the communication effort did not conflict with this metaphor. The series mostly aimed to increase awareness and engagement with the *Rosetta* mission and its goals. Dahlstrom (2014) argues that focusing on one individual as a proxy for a group or process allows audiences to identify and empathise better with groups. Considering the large teams involved in such scientific projects, this kind of anthropomorphism may present an opportunity to showcase the human side of these projects.

In this scenario, many of the 'concerns' raised in the scientific literature above may in fact have been advantageous. The teleological 'goals' of the anthropomorphic spacecraft were easily transferred to the ground crew of scientists and researchers. As a human designed instrument, the 'subjective experiences' of the spacecraft were well-understood. In fact, experiencing the spacecraft's subjective viewpoint of the comet was arguably the entire point of the mission.

Whether the parallels between an anthropomorphised science instrument and the team responsible for it can be generalised to other contexts is a potential avenue for

future research. Dahlstrom suggests characters in a narrative might be similarly useful when representing values in a debate, or when expressing ideas far beyond human scale.

Anthropomorphism invited the audience to form a social connection with the probe and its science team, and feel engaged and effective with a literally distant and alien landscape. As a result, the outreach effort was hugely successful, with few complaints that it was misleading. This is an excellent example of how anthropomorphism can be used strategically – which is why the lack of discussion of it in this report is so concerning. It appears there was little consideration for the mechanisms of anthropomorphism when planning the outreach program, and little discussion of its impact in the evaluation.

Even when anthropomorphism is used successfully in science communication, it appears there is minimal audience research, no formal best practices, and occasionally no consideration at all, of how it works on audiences.

Recommendations

Based on the literature I have reviewed, I suggest the following as a draft set of best practices for using anthropomorphism in science communication, and as avenues for future research.

For practitioners

Greater awareness of anthropomorphism and its effects is the strongest action I feel the literature supports.

Awareness appears to be a key factor in how anthropomorphism works. Awareness is critical in being able to distinguish between ‘strong’, explanatory anthropomorphism, and ‘weak’ metaphorical anthropomorphism. It aids in strategic use by communicators, and aid correction by audiences.

Based on the existing research and theory, I make the following suggestions for science communicators:

(1) Be aware of your usage, intentional and unintentional.

Research shows that anthropomorphism is ingrained in language and thought, and can often be difficult to identify.

(2) Ensure that the audience is aware, implicitly or explicitly, of your usage.

The research suggests that being aware of anthropomorphic reasoning and metaphors may improve audiences' ability to correct it, both in the topic at hand and in future exposure to the idea.

(3) Use anthropomorphism as a communication technique but not an explanation.

Education literature suggests people readily identify and use weaker metaphorical 'as if' anthropomorphism as a shorthand or heuristic when discussing complex ideas. However, such metaphors should only be used to illustrate, never to explain.

(4) Be aware of the contexts where it can be problematic

The scientific literature suggests several areas of concern where anthropomorphic metaphors can undermine or contradict the message being delivered. Many of these concerns are backed up by research in education and science communication. There are three key areas usually identified as particularly prone to misconceptions:

(a) Where causality is important.

(b) Where untestable subjective experiences are important

(c) Where the existence or non-existence of external forces is important

(5) Be aware of the contexts where it can be useful

In some circumstances, the effects of anthropomorphism can align with science communication objectives. Provided the subject matter is not prone to misconceptions, anthropomorphism may be useful where:

(a) A sense of social connection or sense of effectiveness and control is important

(b) A sense empathy and morality is important, particularly in areas like conservation

(c) Human achievements, motivations or inventions are important, in areas like exploration or technology.

(6) Be aware of suitable audiences

The literature suggests that particular audiences have more difficulty distinguishing anthropomorphic metaphors from anthropomorphic explanations. These problematic audiences are generally:

(a) Younger

(b) Less educated

(c) Less experienced with anthropomorphism

For future research

Although these recommendations have a strong basis in existing research, each would also serve as an excellent hypothesis for future research. Future research, especially in science communication, should focus on the effects of anthropomorphism on audiences rather than textual analysis.

Several of the methodologies used in science education may be adapted for use in science communication. Confrontation methodology, as used by Zohar & Ginossar (1998), asks audiences directly whether they *really* believe their anthropomorphic metaphors, and appears to be a powerful way to diagnose whether anthropomorphic reasoning is strong and explanatory or weak and metaphorical. Haslam & Treagust (1987), meanwhile, have developed a multi-tier test for student misconception which could easily be adapted to test for the common misconceptions associated with anthropomorphism.

Finally, future researchers may find it useful to develop a consistent vocabulary around anthropomorphism in science communication, and a framework for where and why anthropomorphism occurs. Discussions about use by communicators, for example, needs clearer distinctions between unconscious, conventionalised and strategic use. Discussion about use by audiences similarly needs distinctions about whether anthropomorphism was intended by the communicator, or interpreted by the audience. Such a framework would likely begin in the psychological literature, but require extension to account for the multiple parties involved in the act of communication.

Conclusion

Anthropomorphism is inevitable. It is an unavoidable component in the way humans think and communicate. Its psychological effects and linguistic patterns are well-documented and powerful, and the concerns of the scientific community around its potential for misconceptions are often justified.

However, it appears to have found a role in the formal teaching of science, as a carefully studied and consciously deployed technique. The key to that technique is awareness, by both the teacher and the student, of its strengths and weaknesses. I

anticipate that, with appropriate research and consideration, anthropomorphism can become an equally useful technique in the emerging field of science communication.

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