



# Moral imagination as an instrument for ethics education for biomedical researchers

Elianne M. Gerrits<sup>1</sup> · Lars S. Assen<sup>2</sup> · Liesbeth Noordegraaf-Eelens<sup>3,4</sup> · Annelien L. Bredenoord<sup>3</sup> · Marc H. W. van Mil<sup>1,5</sup>

Accepted: 19 April 2023 / Published online: 23 May 2023  
© The Author(s) 2023

## Abstract

Moral sensitivity and moral reasoning are essential competencies biomedical researchers have to develop to make ethical decisions in their daily practices. Previous research has shown that these competencies can be developed through ethics education. However, it is unclear which underlying mechanisms best support the development of these competencies. In this article we argue that the development of moral sensitivity and moral reasoning can be fostered through teaching strategies that tap into students' moral imagination. We describe how moral imagination can stimulate the development of these competencies through three different merits of moral imagination. Moral imagination can help students to 1) transfer and apply abstract moral concepts to concrete situations and contexts, 2) explore the perspective of others, 3) explore and foresee the moral consequences of different decisions and actions. We explain these three merits of moral imagination in the context of biomedical research and present a theoretical model for how these merits can be used to stimulate the development of moral sensitivity and moral reasoning. Furthermore, we describe multiple teaching strategies for biomedical curricula that tap into the three merits of moral imagination. These teaching strategies can inspire teachers to design ethics education that activates students' moral imagination for the development of moral sensitivity and moral reasoning.

---

✉ Elianne M. Gerrits  
e.m.gerrits-3@umcutrecht.nl

<sup>1</sup> Center of Education and Training, University Medical Center Utrecht, Utrecht University, Utrecht, The Netherlands

<sup>2</sup> Julius Center for Health Sciences and Primary Care, Department of Medical Humanities, University Medical Center Utrecht, Utrecht, The Netherlands

<sup>3</sup> Erasmus School of Philosophy, Erasmus University Rotterdam, Rotterdam, The Netherlands

<sup>4</sup> Codarts Rotterdam, University of the Arts, Rotterdam, The Netherlands

<sup>5</sup> Center for Molecular Medicine, University Medical Center Utrecht, Utrecht University, Utrecht, The Netherlands

**Keywords** Moral imagination · Ethical decision making · Moral sensitivity · Moral reasoning · Biomedical sciences

## Introduction

Ethics education for non-ethicists generally focuses on teaching students the competencies necessary for making ethical decisions. With this article we aim to develop more theoretical insight into the educational mechanism that can support the development of these competencies. To describe the competencies relevant in this context we use the four-component model of ethical decision making proposed by Rest (1986). The four components described in this model can be summarized as moral sensitivity, moral reasoning, moral intent, and moral behavior. The first two components of this model focus on the competencies necessary to recognize and reason about situations from a moral point of view, while the latter two focus on the development of virtues necessary to commit to moral action (Clarkeburn 2002a; Rest 1986). In this article we focus on the competencies moral sensitivity and moral reasoning as goals for ethics education. Although, the virtues linked to moral intent and moral behavior, such as moral resilience, are also interesting goals for ethics education (for example Bauer and Hermann 2022), we consider moral sensitivity and moral reasoning the basic goals in the educational programs of non-ethicists, especially in undergraduate education (Gerrits et al. 2022). One reason for our choice not to focus on moral intent and moral behavior is, because of the disparity between choosing a course of action and behaving in a concordant manner, these are difficult to translate into concrete learning outcomes in an educational setting (Antes and DuBois 2014; Callahan and Bok 1980; Clarkeburn 2002a; King and Mayhew 2002). Furthermore, understanding the difficulties of committing to moral action in face of disturbances is something that only can be practiced in real-life situations, making it difficult to realize these goals in the limited time that is often ascribed to ethics in the educational programs of non-ethicists, especially in undergraduate education (Clarkeburn 2002a).

## Moral sensitivity and moral reasoning

Moral sensitivity is in this article defined as the ability to recognize if a situation contains moral aspects and which moral concepts, such as principles, values, virtues, and theories, are relevant in a situation. Moral sensitivity is therefore a two-step process that starts with the recognition that specific actions in a situation can harm or benefit others' wellbeing and as such need ethical consideration. This first step is crucial in the process of ethical decision making, as without recognizing the need for ethical consideration, an individual will not start the process of consciously making ethical decisions (Rest 1986; Reynolds and Miller 2015). The second step is the ability to give a context specific interpretation of the moral aspects in a situation (Callahan and Bok 1980; Clarkeburn 2002b; Fowler et al. 2009).

Moral reasoning is in this article defined as the ability to explore which course of action is morally desirable in a situation. When a situation is recognized as morally

relevant, people develop intuitions about what is morally justified. Moral reasoning is the process of inquiry to confirm or falsify these intuitions (Bebeau et al. 1999; Coeckelbergh 2007; Fowler et al. 2009). It involves weighing the consequences of specific actions and considering the perspectives of different stakeholders (Fowler et al. 2009).

Multiple studies have shown that ethics education can support the development of moral sensitivity and moral reasoning (Antes et al. 2009; Clarkeburn et al. 2002; Watts et al. 2017). However, it is unclear through which underlying mechanisms these educational efforts support the development of these competencies. Theoretical insights into the mechanisms that support the development of specific competencies can lead to design criteria that can inspire and support teachers when developing educational interventions (McKenney and Reeves 2018). In this article we argue that moral imagination is a mechanism that underlies many teaching strategies for effective ethics education.

## **Moral imagination**

While several authors, have given descriptions of what moral imagination entails, in this article we follow a rather broad definition. We refer to moral imagination as the use of products of one's imagination, such as narratives, metaphors, or images, in the process of ethical reflection on a specific situation (Johnson 1993). This definition suggests that moral imagination is utilized when a person actively envisions what a situation entails from a moral point of view. Based on the different descriptions of moral imagination in literature, we specify three different merits, or qualities, of moral imagination that can be summarized as transferring moral concepts, perspective-taking, and comparing actions. These merits can be considered thought processes that build on moral imagination. Although the three merits of moral imagination we identify are not discipline-specific, in this contribution we focus on the field of biomedical research, providing some specific refinements relevant to this field. After describing the three merits of moral imagination in the context of biomedical research, we discuss how these merits could be translated into teaching strategies for ethics education for biomedical students.

## **Strengthening moral sensitivity and moral reasoning through three merits of moral imagination**

### **Merit 1: Transferring moral concepts**

The first merit invokes moral imagination to transfer abstract moral concepts, such as principles, values, rules, and theories, to new situations. Transfer in this case concerns the application of knowledge derived in one specific context meaningfully to another context (Gilbert et al. 2011). For biomedical researchers the moral concepts relevant to research practices can be found in frameworks such as the four principles of Beauchamp and Childress (Beauchamp and Childress 2001), general

(professional) codes of ethics, and guiding principles developed by (inter)national research institutes and professional organizations. Some examples include the World Medical Association's (WMA) Declaration of Helsinki, the Council for International Organizations of Medical Sciences' (CIOMS) Guidelines for Biomedical Research, and the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Universal Declaration on Bioethics and Human Health. However, these general prescriptions will not always easily fit the everyday practices of biomedical researchers (cf. Assen et al. 2022; Coeckelbergh 2006; Schuurbijs et al. 2009). To act in accordance with these codes and guiding principles, researchers should be able to recognize whether and how guidelines and principles can be interpreted to guide their research practices (Coeckelbergh 2006; Johnson 1993; Werhane 1998). For instance, the principles of transparency and integrity are often named in literature (Diekmann 2013) and codes of conduct (ALLEA 2017) to provide ethical guidance but are often abstractly formulated. To recognize the relevance of these abstract principles in a specific context, the researcher first must become familiar with these principles. This familiarity includes knowledge of prototypical situations in which these principles are relevant and what possible issues, consequences, and solutions surround these principles. For example, in cases of research integrity, prototypical situations could involve gift authorship or salami publications. Related consequences could be that someone receives an unfair advantage compared to someone with fewer publications (Goddiksen and Gjerris 2022). Once a researcher is familiar with prototypical situations in which specific moral concepts are relevant, it will become easier to recognize them in new situations. Moral imagination is then used to draw similarities and differences between the new situation and the prototypical case in which certain moral concepts are known to be relevant. Thereafter, the moral concepts have to be transferred in an imaginative process to fit this new situation (Johnson 1985). Using moral imagination to understand which moral concepts are valuable in complex situations can stimulate researchers not to be passively guided by general prescriptions but develop an active understanding of how to apply moral principles, values, rules, and theories to new contexts and situations.

## **Merit 2: Perspective-taking**

While the first merit of moral imagination mainly stimulates a personal interpretation of the moral concepts relevant in a situation, the second merit is the use of moral imagination to include the perspective of others and how they are affected by the situation. This form of imagination encompasses the ability to put oneself in a different situation from the perspective of another through perspective-taking (Johnson 1993; Nussbaum 2003). Perspective-taking is suggested to benefit ethical decision making for two reasons. First, when imaginatively experiencing the world of others, we learn to recognize the interests of others and develop a sense of care for their wellbeing (Nussbaum 2003). This cultivation of empathy can increase the importance we give to moral aspects, increasing the motivation to act in ways that benefit these other individuals (Nussbaum 1991). This benefit of perspective-taking is especially relevant in situations where there is a direct personal or professional

relationship between the individual who performs the action and the individual who is affected by this action, such as healthcare professionals and patients (Scott 1997). The second benefit of experiencing a situation from the perspective of someone else is that it provides a better understanding of what moral principles others deem relevant in this situation and, in this way, broadens the individual's interpretation of the situation (Johnson 1993; Kekes 1991). This can result in the recognition of additional moral aspects relevant to the situation that were not recognized through the personal interpretation of the situation. The first benefit, cultivation of empathy through perspective-taking, is for example relevant in considering the perspective of non-human animals used in biomedical experiments. However, three things should be noted in considering this first benefit of perspective-taking in a biomedical context. Firstly, biomedical researchers are often not in direct contact with those affected by their research, such as patients or research participants. Secondly, biomedical research often affects groups or even society as a whole and not a single individual. Finally, the effects of the actions performed by researchers today may lie in the very far future, as the development of biomedical innovations often takes many years or even decades. Despite this distance in both space and time, imagining the perspectives of those affected, even if they concern hypothetical perspectives, is still valuable. Through its second benefit, perspective-taking broadens the interpretation of the situation aiding moral sensitivity. Furthermore, perspective-taking aids the process of moral reasoning when using the perspectives of those involved to analyze how the situation impacts them and how this influences action options.

While perspective-taking offers benefits, limitations should be carefully considered. By letting students experience the perspective of others only in mind, perspective-taking is inherently speculative. As such, the imaginative perspectives that students come up with do not necessarily mimic the vision of someone who actually experienced the situation. Therefore, moral imagination exercises should not be seen as a replacement for real-life engagement with stakeholders. If students believe their experience of others' worldviews is infallible, this may only reinforce existing biases and assumptions. Real-life engagement with stakeholders in biomedical education could involve patient engagement. Meeting patients who experienced illness or were part of a research trial can be a valuable experience for biomedical research students. Additionally, discussions with stakeholders, for example, pharmaceutical companies, members of society whose lives are directly influenced by biomedical innovations, or animal protesters who wish to minimize animal use in experiments, could help biomedical students see how others are impacted by their future professional careers. These discussions provide invaluable insights that help in combating biases and assumptions. Furthermore, they could lead to better interpretations of these perspectives in moral imagination exercises.

### **Merit 3: Comparing actions**

While the second merit of moral imagination adds the perspectives of others to the interpretation of the situation, the third merit uses moral imagination to determine the best possible action based on this interpretation of a situation. This can

be achieved by experimenting with different scenarios in one's imagination and evaluating the potential impact from the perspectives of the different stakeholders involved (Alexander 1993; Johnson 1993). As such, several actions can be compared to select the most desirable one, while additional efforts can be made to anticipate potential residual negative consequences of this action. This aspect of moral imagination can, for example, aid in perceiving design problems and envisioning the possible outcomes of certain design choices (Coeckelbergh 2006). The interpretation of this merit of moral imagination is relevant in the context of biomedical research as it facilitates taking morality into account in making daily decisions as a researcher, for example, when choosing between disposable plastic items in the laboratory or implementing sustainable alternatives (Banks et al. 2020). While in this way researchers could shape their daily practices, eventual biomedical innovations are often not the direct result of one specific research effort. In general, new biomedical innovations are shaped by many years of research, followed by many stages of development involving different actors. In this situation it is generally not possible for one specific researcher to shape the outcomes of this process or come up with a completely different design. As such, innovations are shaped by 'many hands' (Jonas 1979; Waelbers 2009). However, even though many researchers make small contributions to these innovations, this does not refrain them from the shared responsibility for the socially desirable and ethical design and implementation of these innovations (Waelbers 2009). While behavior and actions of individual researchers in the laboratory might have a modest effect on biomedical innovations, a collective of researchers might have a more considerable effect. Such collective deliberation can benefit from active use of moral imagination when devising desirable actions that are relevant to anticipate ethical implications of innovations. Deliberation with and between researchers could inspire actions that inform policy decisions or create awareness of the ethical implications among society. An example of the latter could involve societal dialogues about biomedical innovations and their ethical challenges. These dialogues can result in new insights that can inform and potentially steer biomedical innovations (Reincke et al. 2020).

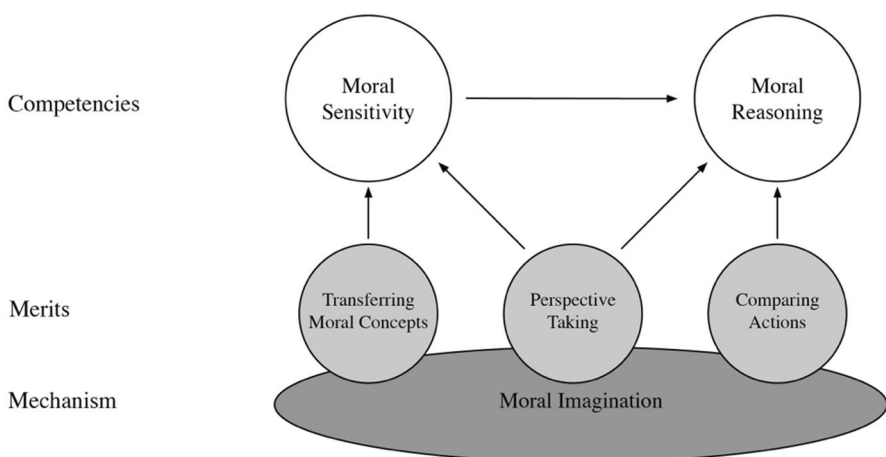
## **An educational perspective on moral imagination for biomedical researchers**

Summarizing the insights from the previous section, we argue that educational efforts that use moral imagination should be directed at the following merits.

- Moral imagination contributes to the ability to transfer moral concepts, such as principles, values, virtues, and theories, to fit specific situations and contexts.
- Moral imagination contributes to the ability to view and understand the situation from different perspectives by shifting one's perspective towards the perspective of another (on individual, group, or societal levels) both in the present and the future.
- Moral imagination contributes to the ability to explore and foresee the moral consequences of different decision and action options.

Stimulating the three merits of moral imagination can aid in developing the competencies to recognize and reason about the ethical implications of biomedical practices. A sequential relation between moral sensitivity and moral reasoning has been described previously (Clarkeburn 2002b; Rest 1986; Weaver et al. 2008). To reason about which actions can be considered moral in a situation, someone first needs to recognize that there are moral aspects in this situation worthy of consideration. The first and second merit of moral imagination aid this first step of moral sensitivity. The ability to look at a situation through different perspectives can stimulate recognition that specific actions can harm or benefits others' wellbeing. By contributing to the ability to transfer moral concepts to a specific situation or context, moral imagination strengthens the ability to make a concrete and context specific interpretation of the moral aspects in a situation. The second and third merits of moral imagination aid moral reasoning. By exploring different action options in mind, while actively envisioning the outcomes of actions through different perspectives, moral imagination strengthens the ability to deliberate which actions have a desirable outcome. The described theoretical framework of moral imagination is summarized in Fig. 1.

In the next section, we describe several teaching strategies that tap into the three merits of moral imagination to develop moral sensitivity and moral reasoning competencies. The overview that we provide of teaching strategies that stimulate moral imagination is not exhaustive. However, the examples described here could guide teachers of biomedical research students to develop teaching strategies that facilitate moral imagination.



**Fig. 1** Overview of the relation between the merits of moral imagination and the competencies moral sensitivity and moral reasoning

## Teaching strategies that build on moral imagination in biomedical education

### Strategies that tap into merit 1

Teaching strategies that build on the first merit of moral imagination use moral imagination to help students recognize how moral concepts, such as principles, values, virtues, and theories, can be transferred to fit specific situations and contexts. To make ethical decisions based on moral principles, values, virtues, and theories, students should be able to apply these general moral concepts to specific situations (Weaver and Mitcham 2016). An example of a framework used in biomedical ethics is the framework of principles by Beauchamp and Childress (Beauchamp and Childress 2001). However, principlism as an approach to analyzing situations is criticized for being too limited in acknowledging the complexity of bioethics issues (Campbell 2003; Walker 2009). The use of only four principles is described as too narrow to provide a complete overview of the issues. Additionally, these principles might not be shared between all cultures (Bredenoord 2016; Walker 2009). While principlism and the set of four principles can be a limitation to recognize all relevant moral principles in a situation (Campbell 2003; Walker 2009), it is a credible starting point for educating biomedical researchers, who in their daily practices do not need to address situations with as much thoroughness as ethicists. As such, these principles could be used in a framework of so-called mid-level principles to recognize the ethical challenges and implications of biomedical research (Arras 1994). Frameworks of mid-level principles involve principles that are in the middle between (abstract) theories and their application, such as making moral judgments in practical settings. Ideally, the mid-level approach not only deducts important principles from ethical theories but also includes other principles derived from ethical codes, field-specific norms, and guidelines (Diekmann 2013).

In addition to being too limited in its number of principles, the framework of Beauchamp and Childress is being criticized for being too mechanical and deductive to encourage thorough development of the analytical and personal competencies needed for ethical reflection (Callahan 2003). Because of this deductive nature, the principlism approach might even hinder the use of imagination in ethical reflection. This could indeed be a pitfall when asking students to use these principles just for their basic meaning without any context-specific interpretation. However, when asking students to specify and balance these principles to fit new situations, these principles can enrich the interpretation of ethical issues (Sokol 2009). When stimulating students to use their imagination to transfer these principles to new situations, in addition to being aware and inclusive to the perspectives of others, the principles can be used as a vehicle and guidance for ethical reflection.

A first exercise to become familiar with moral principles could be to provide exercises or scenarios that show prototypical situations that involve moral principles and discuss the ethical implications that surround them. Moral imagination is then used to envision the prototypical situation and possible issues, consequences, and solutions. Subsequent exercises can focus on transferring principles to new



situations. For students to notice the transferability of concepts to a new context, the context should have a level of similarity that fits in their zone of proximal development (Gilbert et al. 2011). By exemplifying how these new situations are analogous to the prototypical situations, students can practice the transfer of principles to fit situations with increasing complexity. Such an exercise can for example focus on how codes of conduct reflect the time, context, and challenges in which they were established. It might therefore be necessary to update them in accordance with new contexts and challenges. Practicing the transfer of these codes of conduct to new situations can help biomedical students to consider limitations of existing codes of conduct. Using these exercises to discuss necessary changes or updates in codes of conduct can help students realize that such codes are not morally absolute.

### Strategies that tap into merit 2

Teaching strategies that tap into the second merit should invite students to use their moral imagination to look at situations from perspectives that differ from their own. It should be noted that a perspective differs from more superficial notions such as a position or orientation. Exploring a perspective asks for engagement with the circumstances of the other, rather than evaluating the position of another from the position of an outsider (Kahn and Zeidler 2019). Accordingly, perspective-taking exercises yield the best results when a person truly empathizes with the other person and considers emotions, values, and personal circumstances. To be able to recognize the full spectrum of implications a situation can have on a person, it helps to understand the difference between hard and soft impacts. While hard impacts describe the quantifiable and supposedly value-neutral risks, soft impacts describe the impacts that are not quantifiable or difficult to quantify, such as the impact on emotions, values, ideas, and behaviors (Swierstra and te Molder 2012). These soft impacts consider the possible impact of biomedical innovations on an individual's or group's emotions, ideas, and behavior, thus painting a picture of their circumstances. As such, these soft impacts could be used as input for creating fictional personal narratives.

Using fictional personal narratives to discuss cases, instead of using more factual and objective descriptions, stimulates moral imagination to consider someone else's perspective. This can increase a student's understanding of the social impact of the situation and invoke empathy for the psychological state of those involved (Miyasaka et al. 2000). Literature and the arts have also been described as valuable sources for cultivating moral imagination to engage with other perspectives (Nussbaum 1991, 2003; Pardales 2002). Through narratives, drama, or literature, students can engage with characters with a worldview considerably different from their own. This allows students to compare their standpoints to those of others and come to a more sophisticated and balanced opinion (Archila et al. 2022; Leung and Cheng 2022; Miyasaka et al. 2000). Using pre- and post-reading prompts could further stimulate students' reflections. These prompts could ask students to imaginatively change the gender, cultural background, and previous experiences of the individuals involved, or imaginatively change the environment in which a situation happens (Kahn and Zeidler 2016). Using these types of prompts could contribute to a more detailed understanding of the factors that can change someone's experiences of a situation.

In the teaching strategies described above, students are asked to experience a situation through a single perspective, possibly changing to a different perspective when doing the exercise multiple times. However, additional value can be found in experiencing the interplay between different people holding different perspectives. Students can experience such interplay through role-playing exercises. Role-playing exercises are described as having value in ethics education in multiple disciplines (Doorn and Kroesen 2013; Jasemi et al. 2022; Martin et al. 2019; Simonneaux 2001). While not essential, most examples of role-playing exercises ask for students to overcome disagreements and come to a compromise. The benefit of students working towards a conclusion is that it will show that oftentimes it is impossible to come to a solution that is preferential for all perspectives involved. These role-playing exercises can show the necessity of establishing an order of importance in the arguments of those involved to come to a solution (Simonneaux 2001). This process of explicit evaluation of and ranking the importance of the different considerations and arguments aids moral reasoning.

### Strategies that tap into merit 3

The final merit describes the use of moral imagination to decipher the best possible action in cases of moral dilemmas or challenges. Imagination in this case can be used to envision the outcomes of different actions in mind, and by doing this explore different outcomes. An often-described method to compare actions in a professional setting is the use of scenarios or vignettes to reflect on the outcomes of different actions (Boenink et al. 2010; Stermerding et al. 2010; van der Burg 2016). The same scenarios and exercises are useful when considering the ethical implications of biomedical innovations in educational settings. For these scenarios to become plausible, they should not only be based on the imaginative interpretation of the perspectives involved but should also involve research outcomes and expert opinions (Boenink et al. 2010; Stermerding et al. 2010). However, while scenarios should not be based on complete speculation, some specific speculation is necessary (Lucivero et al. 2011). This speculation should consider the desirability of an innovation and what the uptake of the innovation in society would be, by considering the expectations of different stakeholders, including the public, when writing the scenarios and vignettes (Lucivero 2016). For example, stem cell research is accompanied by stem cell hype, which could lead to expectations that researchers cannot meet (Caulfield et al. 2016). A scenario considering the ethical implications of stem cell research might therefore include the clash between the expectations and the eventual biomedical innovation since this could help students reflect on the desirability of this biomedical innovation.

Teaching strategies in which students reflect on different prewritten scenarios portraying the outcomes from multiple actions from the perspectives of different stakeholders can be used for students to start looking for the best outcomes. As a follow-up exercise students can be asked to come up with their own action options and thus develop narratives of what might result from these different actions through

the process of futures thinking. Futures thinking is utilized to detect, invent, analyze, and evaluate probable futures to distinguish preferable futures (Jones et al. 2012). Exercises in which student invent their own possible and probable futures allows students to combine their understanding of relevant scientific concepts, social, political, and economic factors that can influence the future, as well as their knowledge of how the perspectives of others can influence decision-making (Jones et al. 2012). Comparing multiple futures, individually or amongst peers, can stimulate discussion on what futures are preferable. Imagining such preferable futures could stimulate reflection on what meaningful actions could bring about this preferable future. For example, when students need to work on a plan for the implementation of innovations, establishing when the implementation meets the needs and values of different stakeholders can help in identifying meaningful actions in the implementation process (Betten et al. 2018).

## Conclusion

In this article, we have argued that teaching strategies that activate moral imagination are beneficial for the development of moral sensitivity and moral reasoning in the context of ethics education for biomedical researchers. Through its three merits, moral imagination can help to 1) transfer and apply abstract moral concepts to concrete situations and contexts, 2) explore the perspective of others, 3) explore and foresee the moral consequences of different decisions and action options.

Although we focus on ethics education for biomedical researchers, the potential of moral imagination in ethics education is much broader. In clinical ethics education the potential of the merits of moral imagination might even be more obvious. Moral principles like beneficence and non-maleficence are core principles in clinical practice, making them less abstract as compared to these same principles in biomedical research practices. This potentially makes it easier for educators to design moral imagination exercises that resonate with the students. When considering the merit of perspective-taking, the perspective of the individual affected by the situation, the patient, is very prominent in the work of healthcare professionals. This offers a rich and self-evident source for perspective-taking exercises in clinical ethics education. In contrast, in biomedical research it is often unclear which specific individuals are or will be affected, making it much more difficult to activate perspective-taking when students explore biomedical research ethics. Finally, the actions of the healthcare professionals often have a clear and direct impact on the patient. Because real-life clinical cases offer such concrete decision-making scenarios to students, these cases can be used in clinical ethics education to directly tap into the merit of comparing actions and anticipating the consequences of actions. In research ethics the consequences that need to be anticipated by students often lie in the (far) future and are more difficult to imagine. Therefore, additional effort is needed to get students to the point where they feel comfortable and sufficiently equipped to explore such complex future scenarios. This example of the use of moral imagination in clinical education illustrates that the merits we describe are not discipline-specific. Rather, students

in a broad range of disciplines can benefit from education that operationalizes these merits in exercises that are tailored to their specific contexts.

A next step in exploring the educational potential of moral imagination involves empirically testing educational interventions that tap into the described merits. This would further our insight as to how moral imagination supports students in the process of ethical decision making. These interventions can focus on a single merit or combine multiple merits in one exercise. As an example of an intervention focusing on a single merit, close examination of perspective-taking activities can provide additional information on how students integrate different perspectives in their ethical reflections. This could be done by comparing the reflections of students who were prompted to take the perspectives of different stakeholders to the reflections of students who did not receive such a prompt. Interesting findings include the extent to which students recognize the moral aspects during this exercise and how many perspectives students take into consideration. By following students during multiple perspective-taking exercises, insights could be gained into the transferability of perspective-taking. Are students more inclined to consider specific perspectives in other contexts and situations once they have imagined themselves standing in these specific shoes? An intervention that combines multiple merits in one exercise can provide insights into the interplay between the different merits. For example, it would be interesting to examine if a similar sequential relation as is described between moral sensitivity and moral reasoning can be observed between the different merits of moral imagination. By prompting the students to engage in all three merits sequentially, the added effect of the individual merits on ethical decision making can be examined.

In conclusion, it is good to note that extensive and proactive ethical reflection is necessary to guide the implementation of biomedical innovation in society. While ethicists are in the lead of these reflections, we expect it will become more common for researchers to be involved in the extensive ethical reflections of biomedical innovations through collaborations with ethicists and other stakeholders. Therefore, ethics education should aim to prepare biomedical researchers not only to make ethical decisions in their daily professional practices but also to contribute to these extensive ethical reflections of biomedical innovations. Professionals that are familiar with using the merits of moral imagination might be better equipped to collaborate with others to answer the ethical questions that biomedical innovations raise.

**Funding** The second author received funding from the European Union's Horizon 2020 research and innovation program iPSpine under grant agreement no. 825925.

**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

## References

- Alexander, T.M. 1993. John Dewey and the moral imagination : Beyond Putnam and Rorty toward a post-modern ethics. *Transactions of the Charles S. Peirce Society* 29 (3): 369–400.
- ALLEA 2017. The European Code of Conduct for Research Integrity; ALLEA—All European Academies: Berlin.
- Antes, A.L., and J.M. DuBois. 2014. Aligning objectives and assessment in responsible conduct of research instruction. *Journal of Microbiology & Biology Education* 15 (2): 108–116. <https://doi.org/10.1128/jmbe.v15i2.852>.
- Antes, A.L., S.T. Murphy, E.P. Waples, M.D. Mumford, R.P. Brown, S. Connelly, and L.D. Devenport. 2009. A Meta-analysis of ethics instruction effectiveness in the sciences. *Ethics & Behavior* 19 (5): 379–402. <https://doi.org/10.1080/10508420903035380>.
- Archila, P.A., A.M. Truscott de Mejía, and S. Restrepo. 2022. Using Drama to enrich students' argumentation about genetically modified foods. *Science and Education*. <https://doi.org/10.1007/s11191-022-00346-y>.
- Arras, J.D. 1994. Principles and particularity: The roles of cases in bioethics. *Indiana Law Journal (Indianapolis, Ind. : 1926)* 69 (4): 983–1014. <https://doi.org/10.4324/9781315209692-10>.
- Assen, L.S., K.R. Jongasma, R. Isasi, M.A. Tryfonidou, and A.L. Bredenoord. 2022. Roles and responsibilities in stem cell research: A focus group study with stem cell researchers and patients. *Regenerative Medicine* 17 (7): 445–459. <https://doi.org/10.2217/rme-2022-0019>.
- Banks, M., M. Metz, and D.S. Smyth. 2020. The sustainability challenges facing research and teaching laboratories when going green. *Environment* 62 (2): 4–13. <https://doi.org/10.1080/00139157.2020.1708166>.
- Bauer, K., and J. Hermann. 2022. Technomoral resilience as a goal of moral education. *Ethical Theory and Moral Practice*. <https://doi.org/10.1007/s10677-022-10353-1>.
- Beauchamp, T.L., and J.F. Childress. 2001. *Principles of biomedical ethics*. New York: Oxford University Press.
- Bebeau, M.J., J.R. Rest, and M.J. Bebeau. 1999. Beyond the promise: A perspective on research in moral education. *Educational Researcher* 28 (4): 18–26.
- Betten, A.W., V. Rerimassie, J.E.W. Broerse, D. Stermerding, and F. Kupper. 2018. Constructing future scenarios as a tool to foster responsible research and innovation among future synthetic biologists. *Life Sciences, Society and Policy* 14 (1). <https://doi.org/10.1186/s40504-018-0082-1>.
- Boenink, M., T. Swierstra, and D. Stermerding. 2010. Anticipating the interaction between technology and morality: A scenario study of experimenting with humans in bionanotechnology. *Studies in Ethics, Law, and Technology* 4 (2). <https://doi.org/10.2202/1941-6008.1098>.
- Bredenoord, A.L. 2016. The principles of biomedical ethics revisited. In *Islamic perspectives on the principles of biomedical ethics*, Intercultural dialogue in bioethics: Volume 1, ed. Mohammed Ghaly, 133–151. [https://doi.org/10.1142/9781786340481\\_0006](https://doi.org/10.1142/9781786340481_0006).
- Callahan, D. 2003. Principlism and communitarianism. *Journal of Medical Ethics* 29 (5): 287–291. <https://doi.org/10.1136/jme.29.5.287>.
- Callahan, D., and S. Bok. 1980. *Ethics teaching in higher education*. 1st ed. Boston, MA: Springer. <https://doi.org/10.1007/978-1-4613-3138-4>.
- Campbell, A.V. 2003. The virtues (and vices) of the four principles. *Journal of Medical Ethics* 29 (5): 292–296. <https://doi.org/10.1136/jme.29.5.292>.
- Caulfield, T., D. Sipp, C.E. Murry, G.Q. Daley, and J. Kimmelman. 2016. Confronting stem cell hype. *Science* 352 (6287): 776–777. <https://doi.org/10.1126/science.aaf4620>.
- Clarkeburn, H. 2002a. The aims and practice of ethics education in an undergraduate curriculum: Reasons for choosing a skills approach. *Journal of Further and Higher Education* 26 (4): 307–315. <https://doi.org/10.1080/0309877022000021711>.
- Clarkeburn, H. 2002b. A test for ethical sensitivity in science. *Journal of Moral Education* 31 (4): 439–453. <https://doi.org/10.1080/0305724022000029662>.
- Clarkeburn, H., J.R. Downie, and B.O.B. Matthew. 2002. Impact of an ethics programme in a life sciences curriculum. *Teaching in Higher Education* 7 (1): 65–79. <https://doi.org/10.1080/1356251021010039>.
- Coeckelbergh, M. 2006. Regulation or responsibility? Autonomy, moral imagination, and engineering. *Science, Technology, & Human Values*: 237–260. <https://doi.org/10.1177/0162243905285>.

- Coeckelbergh, M. 2007. Imagination and principles: An essay on the role of imagination in moral reasoning. In *Imagination and principles: An essay on the role of imagination in moral reasoning* (Issue September 2014). <https://doi.org/10.1057/9780230589803>.
- Diekmann, S. 2013. Moral mid-level principles in modeling. *European Journal of Operational Research* 226 (1): 132–138. <https://doi.org/10.1016/j.ejor.2012.09.027>.
- Doorn, N., and J.O. Kroesen. 2013. Using and developing role plays in teaching aimed at preparing for social responsibility. *Science and Engineering Ethics* 19 (4): 1513–1527. <https://doi.org/10.1007/s11948-011-9335-6>.
- Fowler, S.R., D.L. Zeidler, and T.D. Sadler. 2009. Moral sensitivity in the context of socioscientific issues in high school science students. *International Journal of Science Education* 31 (2): 279–296. <https://doi.org/10.1080/09500690701787909>.
- Gerrits, E.M., A.L. Bredenoord, and M.H.W. van Mil. 2022. Educating for responsible research practice in biomedical sciences: Towards learning goals. *Science and Education*. <https://doi.org/10.1007/s11191-021-00295-y>.
- Gilbert, J.K., A.M.W. Bulte, and A. Pilot. 2011. Concept development and transfer in context-based science education. *International Journal of Science Education* 33 (6): 817–837. <https://doi.org/10.1080/09500693.2010.493185>.
- Goddiksen, M.P., and M. Gjerris. 2022. Teaching phronesis in a research integrity course. *Facets* 7: 139–152. <https://doi.org/10.1139/facets-2021-0064>.
- Jasemi, M., R. Goli, R.E. Zabihi, and H. Khalkhali. 2022. Educating ethics codes by lecture or role-play; which one improves nursing students' ethical sensitivity and ethical performance more? A quasi-experimental study. *Journal of Professional Nursing*. <https://doi.org/10.1016/j.profnurs.2021.11.002>.
- Johnson, M. 1985. Imagination in moral judgment. *Philosophy and Phenomenological Research* 46 (2): 265. <https://doi.org/10.2307/2107356>.
- Johnson, M. 1993. *Moral imagination*. Chicago: University of Chicago Press. Routledge.
- Jonas, H. 1979. *Das Prinzip Verantwortung: Versuch einer Ethik für die technologische Zivilisation*, 1984. Chicago: University of Chicago Press.
- Jones, A., C. Bunting, R. Hipkins, A. McKim, L. Conner, and K. Saunders. 2012. Developing students' futures thinking in science education. *Research in Science Education* 42 (4): 687–708. <https://doi.org/10.1007/s11165-011-9214-9>.
- Kahn, S., and D.L. Zeidler. 2016. Using our heads and HARTSS\*: Developing perspective-taking skills for Socioscientific reasoning (\*Humanities, ARTs, and Social Sciences). *Journal of Science Teacher Education*. <https://doi.org/10.1007/s10972-016-9458-3>.
- Kahn, S., & Zeidler, D. L. 2019. A conceptual analysis of perspective taking in support of socioscientific reasoning. *Science and Education* 605–638. <https://doi.org/10.1007/s11191-019-00044-2>.
- Kekes, J. 1991. Moral imagination, freedom, and the humanities. *American Philosophical Quarterly* 28 (2): 101–111.
- King, P.M., and M.J. Mayhew. 2002. Moral judgement development in higher education: Insights from the defining issues test. *Journal of Moral Education* 31 (3): 247–270. <https://doi.org/10.1080/0305724022000008106>.
- Leung, J.S.C., and M.M.W. Cheng. 2022. Prioritizing emotion objects in making sense of student learning of socioscientific issues. *Journal of Research in Science Teaching* 1–33. <https://doi.org/10.1002/tea.21801>.
- Lucivero, F. 2016. Too good to be true - appraising expectations for ethical technology assessment. *Language Dynamics and Change* 6 (1). <https://doi.org/10.1163/22105832-00601008>.
- Lucivero, F., T. Swierstra, and M. Boenink. 2011. Assessing expectations: Towards a toolbox for an ethics of emerging technologies. *NanoEthics* 5 (2): 129–141. <https://doi.org/10.1007/s11569-011-0119-x>.
- Martin, D.A., E. Conlon, and B. Bowe. 2019. The role of role-play in student awareness of the social dimension of the engineering profession. *European Journal of Engineering Education* 44 (6): 882–905. <https://doi.org/10.1080/03043797.2019.1624691>.
- McKenney, S., and T.C. Reeves. 2018. *Conducting educational design research*. Routledge.
- Miyasaka, M., H. Yamanouchi, K. Dewa, and K. Sakurai. 2000. Narrative approach to ethics education for students without clinical experience. *Forensic Science International* 113 (1–3): 515–518. [https://doi.org/10.1016/S0379-0738\(00\)00268-1](https://doi.org/10.1016/S0379-0738(00)00268-1).
- Nussbaum, M.C. 1991. The literary imagination in public life. *New Literary History* 22 (4): 877–910.
- Nussbaum, M.C. 2003. *Upheavals of thought: The intelligence of emotions*. Cambridge University Press.

- Pardales, M.J. 2002. "So, how did you arrive at that decision?" connecting moral imagination and moral judgement. *Journal of Moral Education* 31 (4): 423–437. <https://doi.org/10.1080/0305724022000029653>.
- Reincke, Cathelijne M., Annelien L. Bredenoord, and Marc H.W. van Mil. 2020. From deficit to dialogue in science communication. *EMBO Reports* 21(9). <https://doi.org/10.15252/embr.202051278>
- Rest, J.R. 1986. *Moral development: Advances in research and theory*. New York: Praeger.
- Reynolds, S.J., and J.A. Miller. 2015. The recognition of moral issues: Moral awareness, moral sensitivity and moral attentiveness. *Current Opinion in Psychology* 6: 114–117. <https://doi.org/10.1016/j.copsyc.2015.07.007>.
- Schuurbiers, D., P. Osseweijer, and J. Kinderlerer. 2009. Implementing the Netherlands code of conduct for scientific practice—a case study. *Science and Engineering Ethics* 15 (2): 213–231. <https://doi.org/10.1007/s11948-009-9114-9>.
- Scott, A. 1997. Imagination in practice. *Journal of Medical Ethics* 23 (1): 45–50. <https://doi.org/10.1136/jme.23.1.45>.
- Simonneaux, L. 2001. Role-play or debate to promote students' argumentation and justification on an issue in animal transgenesis. *International Journal of Science Education* 23 (9): 903–927. <https://doi.org/10.1080/09500690010016076>.
- Sokol, D.K. 2009. Sweetening the scent: Commentary on "what principlism misses". *Journal of Medical Ethics* 35 (4): 232–233. <https://doi.org/10.1136/jme.2008.028514>.
- Stemerding, D., T. Swierstra, and M. Boenink. 2010. Exploring the interaction between technology and morality in the field of genetic susceptibility testing: A scenario study. *Futures* 42 (10): 1133–1145. <https://doi.org/10.1016/j.futures.2009.12.001>.
- Swierstra, T., and H. te Molder. 2012. Risk and soft impacts. In *Handbook of risk theory*, 1049–1066. Springer.
- van der Burg, S. 2016. A lay ethics quest for technological futures: About tradition, narrative and decision-making. *NanoEthics* 10 (3): 233–244. <https://doi.org/10.1007/s11569-016-0273-2>.
- Waelbers, K. 2009. Technological delegation: Responsibility for the unintended. *Science and Engineering Ethics* 15 (1): 51–68. <https://doi.org/10.1007/s11948-008-9098-x>.
- Walker, T. 2009. What principlism misses. *Journal of Medical Ethics* 35 (4): 229–231. <https://doi.org/10.1136/jme.2008.027227>.
- Watts, L.L., K.E. Medeiros, T.J. Mulhearn, L.M. Steele, S. Connelly, and M.D. Mumford. 2017. Are ethics training programs improving? A Meta-analytic review of past and present ethics instruction in the sciences. *Ethics and Behavior* 27 (5): 351–384. <https://doi.org/10.1080/10508422.2016.1182025>.
- Weaver, K., and C. Mitcham. 2016. Prospects for developing ethical sensitivity in nursing, engineering, and other technical professions education. *British Journal of Education, Society & Behavioural Science* 18 (2): 1–18. <https://doi.org/10.9734/bjesbs/2016/27485>.
- Weaver, K., J. Morse, and C. Mitcham. 2008. Ethical sensitivity in professional practice: Concept analysis. *Journal of Advanced Nursing* 62 (5): 607–618. <https://doi.org/10.1111/j.1365-2648.2008.04625.x>.
- Werhane, P.H. 1998. Moral imagination and the search for ethical decision-making in management. *Business Ethics Quarterly* 75–98. <http://www.jstor.org/stable/41968764>.

**Publisher's note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.