Moral sensitivity and its contribution to the resolution of socio-scientific issues

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This study explores models of how people perceive moral aspects of socio-scientific issues. Thirty college students participated in interviews during which they discussed their reactions to and resolutions of two genetic engineering issues. The interview data were analyzed qualitatively to produce an emergent taxonomy of moral concerns recognized by the participant. The participants expressed sensitivity to moral aspects including concern and empathy for the well-being of others, an aversion to altering the natural order and slippery slope implications. In arriving at their final resolutions, many participants integrated their moral concerns with non-moral factors. The patterns revealed suggest that moral and non-moral concerns act in concert as they influence socio-scientific decision-making.

Introduction

A growing consensus within the field of science education suggests that real-world issues with conceptual ties to science ought to become more central components of science curricula (Driver et al., 1996; Kolstø, 2001; Siebert & McIntosh, 2001; Zeidler, 2003). These issues, termed socio-scientific issues, are often controversial in nature and can be considered from a variety of perspectives. Examples include gene therapy, stem cell research, environmental issues and cloning. It has been argued that the consideration of socio-scientific issues necessarily involves morality (Zeidler, 2003). This paper explores the extent to which existing models of morality account for socio-scientific decision-making. Moral construal (Saltzstein, 1994; Bersoff, 1999), which is consistent with the domain account of morality, and moral sensitivity, an aspect of Rest’s (1986) four-component model, are described and evaluated as heuristic devices for exploring the moral aspects of socio-scientific decision-making.
Moral domains and construal

Domain theorists (Turiel, 1983; Nucci, 2001) suggest that moral problems form a unique sub-set of social knowledge. This tradition isolates moral decision-making from other forms of decision-making such as personal, which describes issues best resolved by exercising individual preferences, or conventional, which encompasses issues subject to social norms. According to this model, moral issues inherently reside within the moral domain. Moral decisions and behaviour result from individual decision makers recognizing the intrinsic morality of particular issues and responding accordingly. This process of recognizing the morality of an issue has been termed construal (Saltzstein, 1994; Bersoff, 1999).

Saltzstein (1994) presents a logical model of moral decision-making given the assumptions just presented. An individual interprets a situation and recognizes its intrinsically moral implications. Moral construal heralds the need for an applicable moral rule or principle that can help dictate an appropriate resolution. Although Saltzstein does not explicitly include moral emotions in his description, the model would become more robust if emotions, which have been shown to influence moral decisions and behaviour in certain circumstances (Hoffman, 2000), were included along with rules and principles. The model is most conceptually clear when it is presented in a linear fashion (i.e. issue confrontation → moral construal → application of moral rules, principles or emotions → issue resolution), but it does not necessarily represent a real-time decision process. The various steps may overlap and be mutually dependent; for instance, the applicability of a moral rule, principle or emotion could signal moral construal.

Many descriptive and empirical accounts of the moral domain and moral construal involve relatively straightforward moral transgressions, such as inflicting physical or psychological harm on others (Nucci, 2001) and petty thievery (Bersoff, 1999). It seems reasonable to expect that the model just described could account for decision-making regarding these issues. However, when compared with real-world moral quandaries, such as the debates surrounding the death penalty, human genetic engineering, war and abortion, the model seems quite simplistic. Turiel (1983) suggests that as the complexity of an issue increases, the likelihood of multiple domain influences also increases. Whereas a simple case of an unprovoked act of aggression might be informed only by the moral domain, decision-making regarding more complex issues may be subject to considerations from the moral, personal and conventional domains.

Moral sensitivity

Rest’s (1986) four-component model offers an alternative but complementary account of the processes described in the domain construal model. Rest postulates the interaction of four components which contribute to moral decisions and behaviour: (i) moral sensitivity (ii) moral judgement; (iii) moral motivation; (iv) moral character. A detailed description of the complete model is beyond the scope of this paper, but
elaborations can be found elsewhere (Rest et al., 1999; Walker, 2002). Central to the research presented here is the status of moral sensitivity. Moral sensitivity describes the tendency for an individual to recognize that some aspects of an issue possess moral implications. According to the four-component model, a person must be sensitive to the moral implications of a particular situation or issue in order for that person to engage in moral reasoning or moral behaviour. The architects and proponents of this model (Bebeau et al., 1999; Rest et al., 1999) suggest that moral sensitivity involves interpreting reactions and feelings of others, understanding cause–consequence chains of events and how these may affect involved parties, empathy and role taking skills in order to ‘become aware that a moral issue is involved in a situation’ (Bebeau et al., 1999, p. 22). The theoretical framework supporting the current study assumes that the recognition of moral principles, rules or guidelines also represent an aspect of moral sensitivity. If an individual interprets a situation in such a way that it violates a rule that she/he holds as morally relevant, then she/he perceives a moral component, and displays moral sensitivity in the context of that situation.

Although literally hundreds of studies have examined moral judgement, relatively little work has been devoted to the explication of moral sensitivity. Much of what has been accomplished has been a result of the development and validation of the Dental ethical sensitivity test (DEST) (Bebeau et al., 1985). This assessment tool presents subjects with recorded dramatizations of four dentist–patient interactions representative of ethical quandaries frequently experienced in the profession. The subjects then assume the role of the dentist and attempt to resolve the dilemmas they observed. Debriefing interviews, during which the subjects can identify the problems they recognized and explain their approach, follow each role play. A sensitivity score is produced by gauging the extent to which the subject recognizes 34 predetermined patient characteristics or dentist responsibilities. A subject receives a rating of 1–3 for each criterion depending on how well they perceive and articulate the moral aspects of each criterion. Studies using the DEST have shown that moral sensitivity can vary significantly among dental professionals as well as across situations (Bebeau et al., 1985; Bebeau & Brabeck, 1987). In addition, DEST scores correlate only moderately (0.2–0.5) (Bebeau & Brabeck, 1987) with Defining issue test (DIT) (Rest, 1975) scores, indicating that while related, moral sensitivity, as measured by the DEST, and moral reasoning, as measured by the DIT, describe unique constructs.

The DEST has also been used as a model for the development of instruments to assess moral sensitivity in other contexts. McNeel (1994) uses the DEST’s framework but modifies the dilemmas. Rather than assessing professional moral sensitivity, McNeel’s test, designed for college students, presents controversial situations frequently faced during the college experience, such as academic cheating, pressure for sex and alcohol abuse. Although subjects recognize morality in some of the contexts faced, perceptions of moral aspects and implications are consistently low with respect to a scenario involving pressure for sex and date rape.

Recognizing the logistical limitations of instruments that mandate dramatizations, role playing and interviewing, Clarkeburn (2002) presents a written assessment of moral sensitivity using a science context. For this test, subjects read a scenario about a
cow genetically modified to produce pharmaceutical milk and write down a maximum of five issues or questions they have regarding the reading. Student responses are scored in a manner consistent with the DEST; their comments and questions are compared with criteria by means of a predetermined rubric. Clarkeburn’s research revealed no significant differences in moral sensitivity among populations of college science students at different stages in their academic careers. However, a simple intervention, which consisted of a series of three discussion group meetings focused on the moral implications of modern science issues, produced significant changes to moral sensitivity. These results suggest that progression through college science curricula does not necessarily increase moral awareness, but appropriate interventions can.

A consistent theme across all of the moral sensitivity research dictates that this construct cannot be measured by instruments that provide subjects with an explicit treatment of moral aspects and pre-existing options, as in the DIT (Clarkeburn, 2002; Walker, 2002). In order for researchers to gain a glimpse of moral sensitivity, subjects require a chance to confront moral aspects of issues on their own terms. Although moral sensitivity has been well characterized in professional dentistry and other contexts have begun to be explored, the investigation of sensitivity to moral considerations in complex, real-life situations remains critical (Walker, 2002).

Socio-scientific issues

The current inquiry focuses on moral sensitivity in the context of socio-scientific issues. Socio-scientific issues describe societal dilemmas with conceptual, procedural or technological associations with science. Many socio-scientific issues stem from dilemmas involving biotechnology, environmental problems and human genetics. The suggestion that issues such as those related to genetic engineering and environmental challenges can be classified together as ‘socio-scientific issues’ is not meant to imply that science and society represent independent entities. On the contrary, all aspects of science are inseparable from the society from which they arise. However, the topics described by the phrase ‘socio-scientific issues’ display a unique degree of societal interest, effect and consequent. These issues are typically contentious in nature, can be considered from a variety of perspectives and do not possess simple conclusions. Several authors (see Pedretti, 1999; Zeidler, 2003) have articulated the need to include socio-scientific issues in science curricula and some (Driver et al., 1996; Pedretti, 1999; Kolsto, 2001) suggest that socio-scientific issues should serve as a vehicle for promoting responsible citizenship in a world growing increasingly more dependent on science and technology.

Purpose

The aim of this study is to explore moral sensitivity in the context of socio-scientific issues. In doing so, the findings address the extent to which competing models of moral decision-making, domain construal and the four-component model can serve
as heuristics for interpreting socio-scientific decision-making. To address this more
general research aim, the study focuses on three inter-related issues. (i) The study
investigates how individual decision-makers recognize, interpret and negotiate the
moral landscapes of two hypothetical genetic engineering dilemmas. (ii) In addition to
describing how individuals perceive the moral implications of their decision-making,
the analysis also assesses the extent to which the moral implications perceived by
decision-makers contribute to their resolution of the issues. (iii) The final research
focus aims to explore the effects of content knowledge and exposure on moral
sensitivity. Study participants are drawn from samples of upper division undergradu-
ate students majoring in biology or psychology. Patterns of moral sensitivity of each
group are explored and compared to elucidate differences that might result from
differential background knowledge relative to genetic engineering.

Method

Assessment of moral sensitivity was accomplished with the presentation of two socio-
scientific scenarios and interviews designed to capture participant perceptions. Each
participant took part in two separate interviews. All interviews were conducted
individually by the author in a small conference room and were audiotaped and
transcribed for analysis. At the outset of the first interview, participants read an
unstructured dilemma, defined as a narrative that does not directly indicate the moral
issues involved nor possess self-evident resolutions (Clarkeburn, 2002), describing
gene therapy for Huntington’s disease (see Appendix A). Participants were subse-
quently asked to describe their reactions, feelings and ideas. They were asked to
describe all of the factors which might contribute to a resolution of this issue. Next,
participants were encouraged to articulate an argument and rationale describing
whether they would support the use of gene therapy for Huntington’s disease. The
discussion then moved to reproductive cloning. Participants read a narrative
describing the potential use of cloning technologies to help infertile couples produce
a child (see Appendix B), described their reactions and feelings and articulated a
resolution of the issue.

A second, individual interview was conducted at least 2 days but no more than 1
week following the first. During the first phase of this session, the author described his
interpretation of participant ideas and arguments articulated in the first interview and
the participants were encouraged to assess the extent to which this interpretation
actually reflected their feelings and to clear up any misinterpretations. In the next
phase, the author followed a semi-structured interview format (see Appendix C)
designed to have participants reveal all of the factors which they considered as they
confronted and tried to resolve each socio-scientific issue. Given the study’s focus on
moral sensitivity, the author took special care to encourage participants to reveal all of
the factors which contributed to their negotiation of the issues without actually
hinting at factors that they might consider. The general format just described was
followed for both the gene therapy and cloning scenarios. Each interview lasted
approximately 20–30 minutes.
Issue selection

The author selected gene therapy and reproductive cloning as the focal issues for three reasons. (i) They present contexts that differ from those previously examined in moral sensitivity research and, therefore, may be useful in expanding our understanding of moral decision-making. (ii) They are pedagogically appropriate for both high school and college science students (Siebert & McIntosh, 2001; Chiappetta & Koballa, 2002), therefore, the results possess potential for contributing to science teaching and curricula. (iii) Previous work (Sadler & Zeidler, 2004) confirmed comprehension of and interest in these issues with a sample of college students similar to the participants in the current study.

Sample

Thirty college students enrolled in a large public university located in southeastern USA participated in the study. Half of the sample was recruited from upper division psychology courses, while the other half was recruited from upper division biology courses. This recruitment strategy was adopted in order to explore the extent to which background knowledge relative to the issues addressed affected moral sensitivity. The issues used in this study, gene therapy and cloning, are clearly associated with the content covered in biology courses. It was assumed that upper division biology majors had been exposed to significantly more content relative to the issues they were negotiating than their upper division psychology major peers. The average participant age was 21.5 years and did not differ significantly between the two sub-groups. The author selected a targeted sample in order to ensure contributions of both male and female students in both sub-groups. Sixteen females (eight in each sub-group) and 14 males (seven in each sub-group) participated in the interviews. Sadler (2002) presents more detailed demographic information on the sample.

Analysis

Assessment of moral sensitivity. The studies of moral sensitivity discussed in the Introduction (Bebeau et al., 1985; McNeel, 1994; Clarkeburn, 2002) assign moral sensitivity scores based on predetermined lists of concerns or aspects that participants recognize in response to a scenario or prompt. These lists of moral considerations had been generated by professional ethicists and participant scores stem from the extent to which responses reflect the ideas deemed moral by the ethicists. The current study does not use an external referent to determine that which constitutes a moral concern or implication. Rather, the current study relies on the participants themselves to identify and describe what they perceive as moral aspects or implications of a particular scenario. In terms of assessing moral sensitivity, the author uses qualitative methods to describe participant considerations deemed moral. In addition, the author calculated the number of moral concerns identified by each participant for both scenarios.
The qualitative description of moral considerations was consistent with inductive data analysis (Lincoln & Guba, 1985) and the constant comparative method (Glaser & Strauss, 1967). Briefly, the author read through the interview transcripts in multiple iterations paying attention to any moral concerns raised by individual participants. In order to qualify as moral concerns, participant statements had to involve interpreting reactions and feelings of others, understanding cause–consequence chains of events and how these may affect involved parties, empathy, role taking skills or recognizing applicable moral principles, rules or guidelines. In the cases of principles, rules and guidelines, participants had to explicitly discuss how and why they interpreted these within a moral framework in order for them to be counted towards moral sensitivity. This standard for interpreting morality is consistent with the description of moral sensitivity presented in the Introduction (namely moral sensitivity involves interpreting reactions and feeling of others, understanding cause–consequence chains of events and recognizing moral principles and guidelines). Following initial identification of participant-defined morality, the author used the emergent themes to form categories to describe the moral considerations to which participants were sensitive. During the second phase of the analysis the author developed a rubric to assess the extent to which moral factors contributed to a participants’ final resolution of the issue. The rubric’s purpose was to describe decision-maker tendencies, not to rank the efficacy of those tendencies, therefore, the rubric contained nominal categories. The second phase of analysis was based on a mixed methods approach where qualitative techniques were used to construct a rubric relevant and applicable to the data and frequency counts according to the rubric were used for comparative purposes. Table 1 presents the rubric used in phase two.

**Table 1. Rubric used to assess the extent to which moral considerations contributed to a participant’s issue resolution**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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<tbody>
<tr>
<td>M</td>
<td>The participant based his/her resolution of the issue on moral considerations.</td>
</tr>
<tr>
<td>IM</td>
<td>The participant integrated moral and non-moral considerations throughout his/her decision-making. The final resolution was consistent with the moral considerations perceived.</td>
</tr>
<tr>
<td>I</td>
<td>The participant integrated moral and non-moral considerations throughout his/her decision-making. The final resolution could not be classified as consistent with or contradicting the moral considerations.</td>
</tr>
<tr>
<td>IN</td>
<td>The participant integrated moral and non-moral considerations throughout his/her decision-making. The final resolution was not consistent with the moral considerations perceived.</td>
</tr>
<tr>
<td>N</td>
<td>The participant did not perceive moral consideration of the issue and therefore based his/her resolution on non-moral considerations.</td>
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**Trustworthiness.** Conventional research paradigms, most commonly associated with the application of quantitative techniques, usually judge the value of a study, at
least in part, on the basis of measures of validity, reliability and objectivity. Although the evaluation of qualitative studies should be no less rigorous, the constructs used in supporting a qualitative study’s value are necessarily different from those employed in the quantitative paradigm (Kirk & Miller, 1986). Lincoln and Guba (1985) present trustworthiness as the construct most appropriate for assessing the merit of qualitative work. Trustworthiness subsumes credibility, which focuses on the degree to which emergent data patterns and the interpretation of those patterns accurately reflect the thoughts, behaviour and decisions of the subjects of inquiry. Trustworthiness also includes dependability, generally analogous to reliability in the conventional paradigm, and confirmability, the degree to which qualitative data and their interpretations can be authenticated.

In the current study, the author built trustworthiness in a variety of ways. Member checking, particularly important for credibility and confirmation, was used to give participants the opportunity to assess the author’s interpretations of their ideas. The two separate interviews served as a means of data triangulation, whereby participant responses could be compared between the two sessions. Dependability was built through peer debriefing. An independent reviewer, experienced with the qualitative nature of taxonomic generation of emerging themes, examined the transcripts and made an independent analysis of the emergent themes. The reviewer and author met to share their emergent taxonomies and came to a consensus on a final scheme for classifying student-generated concerns. The reviewer and author used the consensus classification system to ‘score’ six randomly selected sets of transcripts. Inter-rater agreement exceeded 90%, so it was deemed appropriate for the author to assess the remaining transcripts.

The selection of any research methods necessarily imposes limitations on a research project. By using qualitative methods and adopting a framework whereby the researcher serves as instrument, the researcher introduces the possibility of bias. (However, bias is possible with any type of research.) By engaging participants in personal dialogue and allowing participants to define salient constructs (e.g. moral concerns) in their own terms, the researcher also gains a sensitivity not accessible with other approaches.

Results

Moral sensitivity

All of the participants expressed sensitivity to moral aspects of at least one of the scenarios they confronted. Most of the moral concerns identified by participants in response to the gene therapy scenario could be classified into three categories. Over three-quarters of the participants recognized that the issue concerned the lives, health and well-being of others. These individuals expressed concern over the quality of life and suffering experienced by other people. Just over one-third of the sample suggested that the scenario was subject to a moral imperative against altering the natural order. For many of the respondents, sensitivity to the morality of maintaining the natural
order stemmed from a religion-based ethic. They interpreted aspects of the scenario as involving morality because those aspects challenged their beliefs about the relation between God and humanity. The final category, displayed by approximately 20% of the participants, was based on a slippery slope argument (Boss, 2002). These participants recognized the moral implications of making a decision regarding gene therapy in one context (namely Huntington’s disease) on the future trajectory of human genetic engineering. It should be reiterated that the determination of whether a factor identified by a participant was indicative of moral sensitivity was based on how the participants framed their discussion. For instance, if the participant mentioned that an aspect of the issue was morally or ethically objectionable or that it ‘went against my morals’ or that the situation described a moral obligation, then his/her statement was counted as a moral concern. Some cases were less clear-cut in that a participant did not use the term ‘moral’ or ‘ethical’ but framed their statement in such a way that indicated moral relevance. The following comment does not explicitly mention morality but was judged to be indicative of a moral perspective: ‘gene therapy for disease might be OK, but it would be wrong for us to open that kind of Pandora’s box without recognizing the consequences for other kinds of genetic engineering’ [participant 30 (P30)]. Comments that revealed a sense of concern or empathy were also classified as exemplars of moral sensitivity. Table 2 presents participant quotes taken directly from the interview transcripts to support the legitimacy of the categories just discussed and to provide the reader with a more robust understanding of what the categories represent.

While most of the comments judged to be indicative of moral sensitivity were classified in the three categories just discussed, there were four other classes of statements which showed moral implications. These statements included the moral obligation of physicians, a patient’s right to treatment, the imposition of another’s will on a party unable to make decisions for him/herself and the creation of unjust class distinctions. Because less than 10% of the sample mentioned any single one, the author was hesitant to give them the status of a category, however, they were used when calculating the number of moral concerns a participant articulated (which will be discussed in a later section).

The majority of moral concerns identified in response to the cloning scenario were classified into four categories, three of which were very similar to those developed for the gene therapy scenario. About half of the participants recognized that cloning, at least in this context, possessed the potential to affect the lives of people such as infertile couples, their families and children who, without the advent of cloning, might be adopted. People sharing these ideas expressed empathy, which is characterized as a moral emotion (Hoffman, 2000). Approximately half of the sample noted concern for the moral implications of altering the natural processes of reproduction. As in comments made regarding the gene therapy scenario, many of the statements classified in this category were based on religious ideas. Twenty per cent of the participants were sensitive to slippery slope implications. The only category unique to the cloning scenario circumscribed a sense of moral intuitionism. Individuals making these comments (about one-third of the sample) could not articulate a specific moral
concern, but they found aspects of the scenario morally objectionable. Table 3 presents interview excerpts that support the categories just described.

As in the gene therapy context, several comments were offered in response to the cloning scenario which were only made by one or two participants and therefore are not described as a common category but were deemed moral concerns. These included attention to the rights of potential clones, the imposition of another’s will on a party unable to make decisions for him/herself and the creation of unjust class distinctions.

Given the seminal position of deontological conceptions of morality for both domain theory (Nucci, 2001) and the four-component model (Rest, 1986), which

<table>
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<tr>
<th>Category</th>
<th>Participant quotation</th>
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| Concern for others           | P8: It [gene therapy for Huntington’s disease] would take away from someone having to suffer for 20 years and then you would not have to die so early either. So, I think it is a good idea; it could increase your lifespan. ... I don’t like to see people suffer and if there’s something like this that can eliminate the suffering, then why not?  
P16: It [gene therapy for Huntington’s disease] should be used because it can help people live longer instead of until like 35 years of age. It is not doing anything to hurt the people, it is just trying to help the person. ... It [Huntington’s disease] causes a lot of people to suffer so if it can be fixed, then we should do it. |
| Maintaining the natural order | P7: With my morals, I believe that you should let things take its course like it is supposed to be. To create a new human offspring would not be letting everything take its course. You are creating something that is not supposed to be. ... I find that morally objectionable.  
P20: You are dealing with genes and that is what makes you a unique person and the fact that you are trying to change that; that is trying to change the path that you were made to be. You are trying to change what God intended you to be. I feel we are trying to be God in a sense; we are trying to change what God intended you to be. |
| Slippery slope               | P5: I feel that if it gets too far into something, that there will be problems somewhere down the road. It’s easy to say yes [to gene therapy] if there is something wrong now, but I think ultimately down the road it will just lead to destruction.  
P29: Once it [gene therapy] starts, I don’t really know where to draw the line. ... It [gene therapy] is really scary, as is cloning and the genome project. ... Once it starts, it does not seem like you can really control what can be done with it and what cannot be done with it. |
defined moral sensitivity, the recognition (or lack thereof) of moral principles throughout the interviews deserves mention. Abstract universal principles, which serve as the hallmark of Kohlbergian post-conventional morality (Kohlberg, 1973), were infrequently mentioned in the interviews. Some notable exceptions did exist. As described earlier, one participant discussed the moral obligations of physicians in the light of new technologies like gene therapy and cloning. A few others were concerned about the rights of patients, children and potential clones while considering the scenarios. Although most of the participants demonstrated moral sensitivity, few individuals interpreted morality in a manner consistent with post-conventional reasoning as defined by the Kohlbergian paradigm.

The contribution of moral sensitivity to issue resolution

Participant decision-making was coded according to the categories described in Table 1. This assessment scheme distinguished between decisions based solely on

Table 3. Expressions of moral concern in response to the cloning scenario

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<th>Category</th>
<th>Participant quotation</th>
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<tr>
<td>Empathy towards others</td>
<td>P5: I thought about the parents. That is part of the reason that I am partial because if you look at their situation or you put yourself in that situation and you want to have a baby; this [cloning] is a good choice, so that is what makes it hard. P22: [When I considered the scenario] I was thinking about the mother and father. ... It is tough because it is hard to tell someone; most married couples want to have a child at some point and it is hard to tell them no you cannot have a child.</td>
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<tr>
<td>Maintaining the natural order</td>
<td>P7: I think this is moral. If it was supposed to be, then it would be. Since it is not, it should not be. I do not think they should be able to clone. P28: I think that [cloning] is the ultimate of playing God. You are creating, not necessarily from scratch, but you are creating another person, but it is a replica.</td>
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<tr>
<td>Slippery slope</td>
<td>P3: Once the technology is out there, we might be cloning all kinds of people. Where do we draw the line? When do we say no? When is it OK for one person and not another? P25: I think that one of the problems with using something like cloning is that the technology is increasing at such a rapid rate that we do not; we’re kind of asking whether we should do it or not as it is happening. ... That [cloning] is something that we will be able to do, but we have not considered the implications yet.</td>
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<tr>
<td>Moral intuitionism</td>
<td>P9: I just do not think that [cloning] is right. I do not really know why; it is just this feeling. I do not think it is a good idea. P30: It [cloning] does not seem right; that was my initial reaction; it just does not seem right. I do not know how to expound on that.</td>
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moral considerations (M), on an integration of moral and non-moral considerations (I, IM and IN) and on non-moral considerations only (N). Integrated responses were further divided into those which were consistent with the moral considerations articulated (IM), those which were not consistent with the moral considerations articulated (IN) and those which could not be classified as consistent with or contradictory to the moral considerations articulated (I). This final category (I) was used to classify responses that contained multiple, conflicting moral considerations. For instance, in response to the cloning scenario, some individuals expressed empathy towards the infertile couple leading them to support cloning, but the same individuals also noted moral objections to altering the natural order leading them to oppose the procedure. Regardless of the final resolutions (namely to support or oppose reproductive cloning) in these cases, the position was both consistent with and contradicted some of the moral considerations articulated and, therefore, the IM and IN categories were inappropriate.

In order to provide a better description of the integrated categories (I, IM and IN), it is necessary to briefly discuss the non-moral considerations that contributed to issue resolution. In response to both scenarios, most participants focused at least part of their decision-making efforts on non-moral considerations. They mentioned a diverse array of concerns, questions and ideas that showed no direct link to moral principles, rules, emotions, issues or intuitions. For example, participants discussed the purpose of medicine and science, technological concerns, financial concerns and evolutionary consequences. In deciding whether comments identified non-moral considerations, the author and independent reviewer carefully examined the context of the remarks to ensure that the participant did, in fact, offer the statement divorced from any possible moral implications. For example, it might be possible to discuss the purpose of medicine and science in a moral context, however, in the cases presented here individuals made no attempt to associate their discussion of the aims of medicine and science with morality. The exchange below between the interviewer and a participant (P26), taken from a transcript, illustrates this point.

Interviewer: What factors were influential in determining your position regarding the gene therapy issue?

P26: I am thinking about the purpose of medicine. That is the reason we do surgery—we do surgery because your knee is hurting. ... Now if someone has Huntington's disease, the only thing we can do is treat it with gene therapy ....

Interviewer: In arriving at your decision, did you consider the perspective or feelings of anyone involved in the scenario? If so, describe what you thought about.

P26: No, I did not. I thought about the purpose of medicine.

In this example the participant could have invoked concern for the well-being of others and the expression of empathy, but even when explicitly asked about whether she/he thought about the issue in a personal context which might suggest moral sensitivity, the participant offered no information suggestive of this perspective. It is impossible to make this judgement based only on a brief excerpt, but the rest of the transcript also supported the conclusion that this individual thought about the
purpose of medicine with a functional perspective divorced from any moral implications. It would certainly be possible for moral philosophers and ethicists to ascribe a moral component to the ‘purpose of medicine’, but in the best judgement of the author and the independent reviewer, a moral interpretation of the participant response was not appropriate. The researchers worked to preserve the voice of the participants as accurately as possible.

Non-moral factors were frequently as influential as the moral aspects described earlier in determining issue resolution. In some cases, moral and non-moral concerns were complementary with respect to the direction of their influence (i.e. both supported or opposed use of a particular technology), whereas in other instances moral and non-moral concerns provided conflicting influences (i.e. one supported use while the other opposed use). Table 4 presents frequency counts for the classification of each scenario resolution.

Table 4 reveals that resolution classifications were diverse for both scenarios. The contribution of moral and non-moral concerns varied by participant for the gene therapy and cloning scenarios. These results led to the question whether or not resolution classification was independent of context. In other words, did participants display the same resolution patterns in response to both scenarios. For the purpose of this analysis, all of the integration categories (I, IM and IN) were collapsed into one group (I). Each participant was assigned one of six codes to describe their resolutions on both scenarios: MM, MI, MN, II, NI or NN. MM indicated that an individual based both of his/her resolutions on moral concerns. MI indicated that one decision was based on moral concerns while the other was based on an integration of moral and non-moral considerations. The remaining four codes operated in the same manner as the two just explicated. Table 5 presents the distribution of these codes and the expected distribution if the influence of moral and non-moral concerns were independent for the two scenarios. Because of the relatively small sample size (n=29) and the fact that half of the expected values were less than 5, a $\chi^2$ analysis of independence was inappropriate. Table 5 is presented for descriptive purposes. Generalizable conclu-

<table>
<thead>
<tr>
<th>Scenario</th>
<th>M</th>
<th>IM</th>
<th>I</th>
<th>IN</th>
<th>N</th>
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<tbody>
<tr>
<td>Gene therapy</td>
<td>4</td>
<td>9</td>
<td>7</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Cloninga</td>
<td>4</td>
<td>6</td>
<td>7</td>
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</tbody>
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M, resolution based on moral considerations; IM, decision-making based on an integration of moral and non-moral considerations, but final resolution is consistent with moral considerations; I, resolution based on an integration of moral and non-moral considerations; IN, decision-making based on an integration of moral and non-moral considerations, but final resolution is not consistent with moral considerations; N, resolution based on non-moral considerations.

*The cloning frequency counts do not sum to 30 because one participant did not articulate a final resolution of this scenario.*
sions are impossible to draw, but in this sample the influence of moral concerns on issue resolution does not appear to be completely independent.

**Sub-group differences**

The final research focus was an investigation of differences in moral sensitivity between the two sub-groups which comprised the sample (i.e. biology majors and psychology majors). This issue was addressed with a mixed methods approach: the moral concerns raised by individuals in both groups were compared qualitatively and the number of moral concerns articulated by each participant in response to both scenarios was calculated and compared between the two groups. The number of moral concerns raised by participants in response to the gene therapy scenario ranged from 0 to 4; the count ranged from 1 to 3 for the cloning scenario. The average number of concerns members of each sub-group raised and the standard deviations are presented in Table 6. On average, participants from both groups articulated between 1.6 and 1.9 moral concerns in response to each scenario. While it was theoretically possible to test for statistically significant differences between the number of concerns raised in response to each scenario by each group using a multivariate technique such as a Hotelling’s $T^2$ analysis, the differences suggested no practical significance.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Major</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gene therapy</td>
<td>Biology</td>
<td>1.6 ± 0.63</td>
</tr>
<tr>
<td></td>
<td>Psychology</td>
<td>1.7 ± 0.80</td>
</tr>
<tr>
<td>Cloning</td>
<td>Biology</td>
<td>1.9 ± 0.64</td>
</tr>
<tr>
<td></td>
<td>Psychology</td>
<td>1.7 ± 0.80</td>
</tr>
</tbody>
</table>

Table 5. The observed and expected distribution of resolution influences for both scenarios

<table>
<thead>
<tr>
<th></th>
<th>MM</th>
<th>MI</th>
<th>MN</th>
<th>II</th>
<th>NI</th>
<th>NN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>11</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Expected</td>
<td>0.57</td>
<td>4.64</td>
<td>2.27</td>
<td>10.09</td>
<td>9.57</td>
<td>2.27</td>
</tr>
</tbody>
</table>

MM, both resolutions based on moral considerations; MI, one resolution based on moral considerations and one based on an integration of moral and non-moral considerations; MN, one resolution based on moral considerations and one based on non-moral considerations; II, both resolutions based an integration of moral and non-moral considerations; NI, one resolution based on non-moral considerations and one based on an integration of moral and non-moral considerations; NN, both resolutions based on non-moral considerations.
Qualitative analyses of the actual comments also failed to detect clear instances of moral sensitivity displayed by the groups. The biology and psychology majors displayed the same general patterns of moral concerns. For instance, in response to the gene therapy scenario nearly all of the participants in both groups recognized the feelings and interests of disease sufferers. In response to the cloning scenario, roughly half of both groups identified violation of the natural order as a possible moral concern. In fact, members from both groups made comments representative of the categories described in Table 1 with practically the same relative frequencies. The only pattern that did emerge as a result of sub-group differences was the types of non-moral considerations discussed. The biology students expressed concern over technological issues associated with and the evolutionary implications of genetic engineering more frequently than the psychology students. However, this difference did not produce any noticeable changes in the moral sensitivity expressed by the two groups.

Discussion

Moral decision-making in the context of socio-scientific issues

This paper began with the description of a simple model of moral decision-making. The model suggested that moral problems could be solved by first construing the problem as moral and subsequently applying the appropriate moral principles, rules or emotions. Although the model might explain relatively straightforward decision-making, it seems unlikely that such a model could account for decision-making regarding complex problems produced by realistic contexts. Socio-scientific issues define one such set of complex problems and the results of this study suggest that the negotiation of these issues cannot be appropriately captured by the simple domain construal model. Moral sensitivity offers a slightly different interpretation of the recognition of the moral aspects of a problem. The four-component model subsumes moral sensitivity and suggests that the recognition of moral aspects is only one of four processes that lead up to the resolution of dilemmas with moral ramifications. The data produced in this study are more consistent with this model because it allows for the integration of multiple factors in the decision-making process. Having concluded that moral sensitivity is a useful heuristic for analyzing socio-scientific decision-making, the context of decision-making must be explicitly recognized. The participants involved responded to hypothetical scenarios presented in a narrative format. Confronted with the same issues in a more personal context (e.g. facing the choice of gene therapy for one’s own child), participants may display different patterns of decision-making. However, the results are significant for educational contexts which necessarily present socio-scientific issues in more impersonal contexts similar to the methods employed here.

The participants in this study expressed sensitivity to a variety of moral considerations as they confronted issues related to gene therapy and cloning. However, for most of the participants these moral considerations did not prescribe
their decision-making. They also recognized many non-moral factors which became intertwined with the perceived moral considerations. Although some participants focused exclusively on either moral or non-moral considerations when producing a resolution, most integrated both types throughout their verbal ruminations on the issues. Even when a participant considered only one class of considerations, regardless of whether the class was moral or non-moral, the structure of decision-making did not seem to differ from the integrated approaches. In short, the data support the notion that individuals are generally sensitive to moral aspects of socio-scientific issues, but that this sensitivity does not alter the nature of decision-making. Moral sensitivity introduces additional aspects to ponder when attempting to reach a decision, but it does not seem to signal a unique pattern of reasoning, as might be expected in a domain account of socio-scientific issues. The complex interaction of moral and non-moral factors in the context of socio-scientific decision-making revealed in this study complements similar findings from literature related to the ‘public understanding of science’. This domain, which has focused on the public’s response to local and personal issues related to science, has also cited multifaceted effects of morality, emotion and social structures on the resolution of socio-scientific issues (Layton et al., 1993; Luján & Todt, 2000).

Although this study’s focus was most closely aligned with component 1 of the four-component model, moral sensitivity, the assessment of the extent to which moral concerns contributed to issue resolution was also related to component 3, moral motivation. Moral motivation, as a construct, represents the process of balancing moral and non-moral values (Rest, 1986). All of the resolutions that were classified as integrated (codes I, IM and IN) identified cases in which the decision-maker negotiated different factors that influenced his/her resolution. The various factors often pitted an individual’s value systems, moral and non-moral, against one another. For instance, some participants valued both the advancement of science and maintenance of the natural order. These values presented conflicting influences and the relative importance of any one value varied among individuals. The results presented herein support the four-component model, at least with respect to components 1 and 3, as a heuristic device for dissecting moral decision-making. However, when using the model it is imperative to consider that the various components do not necessarily represent temporally or cognitively distinct processes (Rest, 1986; Walker, 2002). The participants in this study revealed no tendencies to compartmentalize the interpretation of moral considerations and the negotiation of these considerations with non-moral factors.

This study did not attempt to measure moral reasoning, which is most closely associated with the second component of the four-component model (Rest, 1986), however, one of the patterns revealed speaks to the role of moral reasoning regarding socio-scientific issues. Assessments of moral reasoning are usually based on the Kohlbergian scheme of morality, which posits application of universal principles of justice as the highest form of reasoning (Kohlberg, 1973; Rest et al., 1999). In order for an individual to apply these principles in reasoning, she/he must be sensitive to their pertinence. In this study, few individuals displayed such an awareness.
Irrespective of the reason why post-conventional concerns were not recognized by the participants, the Kohlbergian model of morality would not be a robust descriptor of the decision-making displayed. Whereas the context of Kohlbergian dilemmas ideally takes a back seat to the application of principles, it seems that the context of socio-scientific issues, which can involve a plethora of interactions and interpretations, are of the utmost importance. Therefore, future studies of socio-scientific decision-making should consider using more inclusive models of moral development than the more narrow Kohlbergian view as an investigatory framework.

Educational implications

Although the conclusion that most students displayed moral sensitivity in the context of socio-scientific issues is not surprising, the exploration and description of the kinds of concerns participants identified is important. The findings indicate the kinds of moral concerns that students are likely to perceive when negotiating genetic engineering issues. The results may also give educators an idea about the kinds of factors that are not frequently considered by students. Science and ethics educators may assume that deontological principles play a significant role in the manner in which students negotiate controversial scientific issues, however, these results do not support that assumption. If educators desire students to adopt principle-based perspectives, then they need to explicitly address how principles might be applied in socio-scientific contexts. This study’s results support Clarkeburn’s (2002) finding that science coursework alone does not increase students’ sensitivity to moral aspects of scientific issues. In the current study, upper division biology students and psychology students did not reveal differences in sensitivity displayed in response to genetic engineering issues. Despite the fact that the biology majors had taken more courses related to genetic engineering than the psychology majors, both groups demonstrated similar patterns of sensitivity. Based on Clarkeburn’s (2002) positive results with interventions which specifically encouraged the exploration of the morality in the context of science, similar approaches with various socio-scientific issues might be helpful in advancing moral sensitivity among students.

One of the reasons that some authors (Driver et al., 1996; Kolstø, 2001; Zeidler, 2003) have called for the inclusion of socio-scientific issues in science curricula has been their potential to awaken students to the dynamic interactions of science and society. Central to these interactions are the moral and ethical issues that arise from the interface between science and society. The argument has been posited that in order for individuals to participate responsibly in democratic societies dependent on science and technology, then they require an appreciation of the moral implications of their decisions and the opportunity to exercise their decision-making skills in the context of socio-scientific issues (Pedretti, 1999; Sadler & Zeidler, 2004). The data in this study suggest that college students are, in fact, sensitive to at least some of the moral implications of these issues, a result which supports the notion that socio-scientific curricula could be used as a stimulus to encourage student consideration and appreciation of the complex interdependencies of science, society and morality.
Future studies would be useful for determining the extent to which other samples (for example high school and middle school students) reflect the patterns observed in this study, as well as for investigating effective means of integrating socio-scientific issues into science curricula.

References

Appendix A. Gene therapy interview scenario

Germline gene therapy is a potential genetic technology. (It has not yet been used in humans.) This type of gene therapy would involve altering a gene in an individual’s sex cells (egg or sperm cells) or in a newly conceived embryo (just after fertilization). The intent of gene therapy would be to remove an undesirable gene and replace it with a preferred gene. The sex cell or embryo resulting from gene therapy would possess the ‘new’ gene and would be missing the ‘old’ gene.

Huntington’s disease is a neurological disorder caused by a single gene. The symptoms usually start between the ages of 35 and 45. The first symptoms include uncontrollable body spasms and cognitive impairment. As the disease progresses, patients become physically incapacitated, suffer from emotional instability and eventually lose their mental faculties. Huntington’s disease usually runs its course over a period of 15–20 years and always results in death. No conventional treatments are known to work against Huntington’s disease.

Because Huntington’s disease is controlled by one gene, it could be a candidate for gene therapy. Should gene therapy be used to eliminate Huntington’s disease from sex cells (egg cells or sperm cells) that will be used to create new human offspring?

Appendix B. Cloning interview scenario

The process of cloning is designed to produce an organism genetically identical to another organism. In the normal process of mammalian reproduction, genetic material from an egg cell and a sperm cell combine during fertilization to produce a new genetic combination. The new genetic make-up of the offspring is distinct from both parents. The fertilized egg cell will eventually develop into a new offspring.

In cloning, the genetic material of an unfertilized egg cell is removed and a complete set of genetic material (from a donor) is inserted into the egg cell. The donor genetic material can be relatively easily obtained from most body cells (for example skin cells). The egg cell which carries the donor’s genetic material can be stimulated to grow as if it were a fertilized egg. The cloned offspring would be genetically identical to the donor organism.

Many otherwise healthy couples are unable to bear children. Modern reproductive technologies like fertility drugs and in vitro fertilization have enabled some of these individuals to have their own children. However, some couples remain infertile and unable to have a baby. For these individuals, cloning could be used as another reproductive technology. In this case, one of the parents would serve as the genetic donor. The donor’s genetic material would be inserted into an egg cell and then the embryo (the egg carrying a complete set of the donor’s genetic material) would be implanted into the woman. The embryo would develop into a fetus and eventually be born as a baby.

Should individuals who want to carry and have their own children be able to choose cloning as a reproductive option?
Appendix C. Second interview protocol

Prior to asking any questions, the interviewer would describe his interpretations of participant ideas articulated during the first interviewer. The participant then had a chance to confirm this interpretation and/or clear up misinterpretations.

1. What factors were influential in determining your position regarding the gene therapy/cloning issue?

2. What kinds of concerns did you think about upon reading this prompt?

3. Did you immediately feel that gene therapy was the right/wrong course of action in this context? Did you know your position on the issue before you had to consciously reflect on the issue?

4. In arriving at your decision, did you consider the perspective or feelings of anyone involved in the scenario? If so, describe what you thought about.

5. Do you think that gene therapy/cloning involves morality or ethics in any way? If so, explain how?
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