

Attitudes towards human reproductive cloning, assisted reproduction and gene selection: a survey of 4600 British twins

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BACKGROUND: Surveys have shown opposition to human reproductive cloning (HRC) in many countries. Views of identical (monozygotic, MZ) twins are of particular interest, as they naturally share 100% of their genes. We investigated attitudes of British twins towards HRC in the context of assisted reproduction technologies (ART) and gene selection. **METHODS:** About 4651 identical and non-identical (dizygotic, DZ) twins expressed their degree of agreement or disagreement to nine statements relating to ART, gene selection and HRC in a self-completion questionnaire. **RESULTS:** Most subjects (70% and 78% respectively) did not regard the use of medical technologies to treat infertility as interfering with either nature or God's will, despite believing that infertility is not a disease (54%). Attitudes to gene selection and HRC were context dependent, with more favourable views towards preventing serious diseases than towards enhancing traits. About 44% supported a permanent ban of HRC. MZ twins were significantly more likely to agree that HRC should be allowed for medical purposes, such as saving a sibling's life, than were DZ twins. Increasing religiosity generally correlated with more negative attitudes. **CONCLUSIONS:** Many attitudes are context dependent. More positive views of MZ twins towards HRC could be linked to their experience with being genetically identical.

Keywords: survey; attitudes; twins; assisted reproduction; human reproductive cloning

Introduction

Due to its concern with genetic sameness, the topic of human reproductive cloning (HRC), which represents the central focus of this survey, is intimately linked with both the somatic and social aspects of twinship. Of course, there are significant differences between natural monozygotic (MZ) twins—who are genetically identical due to the splitting of the oocyte after fertilization—and 'clones', created by means of somatic cell nuclear transfer (SCNT). First, 'clones' would be a result of asexual reproduction (without gamete fusion). Second, if HRC ever became a reality, a 'clone' would be born later than his/her progenitor (the donor of the DNA), whereas MZ twins are born at the same time, a factor that is likely to have significant impact on the kind of relationship established (Stewart, 2003; Segal, 2005, 2006).

Previous research on public attitudes towards HRC has been partly unsatisfactory. As HRC plays no practical role in people's lives, merely asking people's opinion on HRC in general is unlikely to generate findings that go beyond a repetition of the current media representation of the public

debate on the topic. Mass media tend to portray 'clones' either as suffering mammals, dangerous tyrants, or soulless carbon copies (Battaglia, 1995; Nerlich and Clarke, 2003; Lane, 2006). Apparently, the assumption that human beings produced by means of SCNT would be soulless, or even 'androids', exposes a deep lying fear of the destabilization of what it means to be human. One of the first known stories about an attempt to create a human being asexually, the story of the Golem, might be one of the points of reference for such fears: the Golem is of human shape, but it lacks a soul; it is human in shape but not in essence (Sherwin, 2000). Like the Golem, movies and other mass media often portray 'clones' as behaving and looking human at the outside, although their 'inner' humanness is dubious. Not surprisingly, such traditions and representations have considerable impact on how people outside of the life science community relate to the concept of HRC.

Surveying twins [MZ twins, as well as dizygotic (DZ; non-identical or fraternal) twins as a control group] provide the opportunity to reach the only group for which genetic sameness has a practical meaning in the sense that it has tangible implications for various spheres of the respondents lives: looking

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very similar, frequently being mistaken for one another by one's social environment, being regarded by some outsiders as being only 'two halves', having a 'perfect match' for organ donations in times of need, expecting to suffer from similar medical problems etc. Questions, such as how MZ twins conceptualize their special bond, what advantages and disadvantages they ascribe to identical twinship and how they relate to the claim that HRC is unethical because it entails the deliberate creation of genetically identical individuals, have already been explored in a qualitative study by Prainsack and Spector (2006). One of the findings of the qualitative study was that some MZ twins perceive the problematization of genetic sameness in the cloning debate as offensive. Respondents found it difficult to relate to the fact even they, as natural twins, are frequently attributed with flawed individuality or underdeveloped senses of self (Davis and Davis, 2007). Therefore, in the current survey, we explored quantitatively whether MZ twins had a more positive attitude towards scenarios of HRC than DZ twins. In addition, instead of treating HRC as an isolated topic, we related it to the fields of assisted reproduction technologies (ART) and gene selection prior to birth, as both influence the meaning of the concept of HRC.

Materials and Methods

Participants

We sent questionnaires to 7988 twins, who are volunteers from the TwinsUKAdult Twin Registry, ascertained from the general population and shown to be comparable to age-matched population singletons (Andrew *et al.*, 2001). These unselected MZ and DZ twins have been recruited since 1992 using twin registers and national media campaigns and have been used in a wide variety of studies (www.twinsuk.ac.uk). Historically, the cohort is predominantly female, so women are overrepresented in the study sample (Table 1). Zygosity was determined by a validated questionnaire and genotyping in cases of uncertainty. MZ and DZ twins were represented almost equally in our sample (49% and 51%, respectively).

Questionnaire

Nine statements regarding the moral and legal permissibility of ART and HRC, under the heading 'Modern Science', were included in a 16-page questionnaire covering topics such as life style patterns, personality traits and life events. Respondents were unaware of our objective to test MZ versus DZ twins' attitudes towards HRC, ART

and gene selection. We have no reason to assume that respondents' attitudes were affected by the other topics or the ordering of the questionnaire.

The nine 'Modern Science' statements, which had been compiled by the authors after sending open-ended pilot questionnaires to volunteers, covered three main areas: views on infertility (statements A–C), views on selecting genes prior to birth (statements D and E), and views on HRC (statements F–I).

Respondents were asked to what extent they agreed or disagreed (using a seven-point scale, with the anchor points 'strongly agree' = 1 to 'strongly disagree' = 7) with each statement. Although the seven-point scale was retained for analysis purposes, for ease of presentation in the tables, response categories were combined to give just five: point 1, strongly agree; points 2 and 3 on the scale were counted as 'agree', whereas points 5 and 6 were counted as 'disagree' and point 7, 'strongly disagree'. Point 4 was considered as neither agreement nor disagreement; in the tables, we labelled this category of respondents as 'undecided'.

The questionnaire also recorded demographic details including information on age, the number of biological children, sex and religion (denomination and degree of religiosity). The fact that the register was established as a resource for genetic research into common complex diseases in Caucasian populations precluded the inclusion of individuals from other ethnic backgrounds. In the current survey, this might have resulted in more negative attitudes towards the topics of our research, as other studies have found Christian populations to be more sceptical towards new medical technologies than non-Christian populations (see below).

Data analysis

All analyses were performed using STATA software. Spearman rank correlations were used to assess the relationship between responses to each statement and the age and religiosity of respondents. The chi-square statistic for linear trend (based on the Cochran–Armitage test) was used to compare differences in responses between men and women, MZ and DZ twins and between those who had biological children and those who did not have children. This test assesses whether any observed trend between response rates and the dichotomous variables (gender, zygosity and children) is linear and therefore amenable to useful interpretation.

Results

We received replies from 4651 twins aged between 16 and 83 (mean age 54). All were Caucasians from all over the UK, 4101 were female. Two-thirds (64%) of our respondents said they belonged to the Church of England, followed by 'Other Christians' (11%) and Roman Catholics (10%). Christians therefore constituted 85% of our respondents. The rest comprised the two non-religious groups of 'atheists' (6%) and 'agnostics' (5%). Jews constituted the smallest group (1%). Slightly less than half (47%) of our respondents categorized themselves as not at all or not very religious. There was no difference between responders and non-responders for the aforementioned variables (sex, age and religion).

Views on infertility and ART

Twice as many respondents disagreed (54%) than agreed (27%) with the statement that 'infertility should be classified as a disease' (Table 2, statement A). Despite the apparent prevalent belief that infertility is not a disease, the majority

Table 1: Demographic data of twins in our survey

	Total	MZ (<i>n</i> = 2271)	DZ (<i>n</i> = 2320)
Age (mean and age range)	54 (16–83)	54 (17–83)	54 (16–82)
Females (%)	89	88	90
R with biological children (%)	76	75	77
Degree of religiosity (mean) ^a	5	5	5

R, respondents.

^aOn a scale from 0 = "not at all" religious to 10 = "very religious".

Table 2: Views on infertility

Statement	Reply	Total %	Gender			Zygoty			Biological children			Age Sp	Religiosity Sp
			M %	F %	<i>P</i>	MZ %	DZ %	<i>P</i>	Children %	No children %	<i>P</i>		
(A) Infertility should be classified as a disease	Strongly agree	8	6	9		9	8		7	9			
	Agree	19	14	19		19	18		15	20			
	Undecided	19	21	18	<0.02	17	20	NS	19	19	<0.001	NS	NS
	Disagree	21	23	21		21	21		23	20			
	Strongly disagree	33	36	33		34	33		36	32			
(B) We should not use medical technologies to treat infertility as we are interfering with nature	Strongly agree	4	4	4		4	4		5	3			
	Agree	9	10	9		10	9		9	9			
	Undecided	17	18	17	NS	16	17	NS	18	16	NS	-0.146	-0.094
	Disagree	31	29	31		30	31		33	31			
	Strongly disagree	39	39	39		40	39		35	41			
(C) It is against God's will to use medical technologies to treat infertility	Strongly agree	3	3	3		3	2		4	3			
	Agree	7	7	7		7	7		6	7			
	Undecided	12	12	12	NS	12	13	NS	14	12	NS	-0.156	-0.192
	Disagree	23	24	23		23	13		22	23			
	Strongly disagree	55	55	55		55	55		54	55			

P, chi-square test for linear trend; Sp, spearman rank correlation; NS, not significant; % may not add upto 100 due to rounding.

of our respondents (70%) did not regard treating infertility with the help of medical technology as an instance of interfering with nature (Table 2, statement B). Similarly, although infertility was not seen as a disease by the majority of our respondents, only 10% believed that 'it is against God's will to use medical technologies to treat infertility', whereas 78% disagreed with this statement (Table 2, statement C).

We found correlations with the degree of religiosity of a respondent and his/her view on infertility regarding two of the three statements in this category. The more religious our respondents were, the more they believed that 'we should not use medical technologies to treat infertility as we are interfering with nature' (statement B; $P < 0.001$) and the more they saw the use of medical technologies to treat infertility as an instance of contradicting God's will (statement C; $P < 0.001$). Men were less likely than women to classify infertility as a disease (statement A); 20% of our male respondents agreed that it was a disease compared with 28% of our female ones. The difference between responses of both genders to this issue was significant ($P < 0.02$). Our findings also showed that respondents without biological children were more likely than those with biological children to classify infertility as a disease (statement A; $P < 0.001$). We found no differences between MZ and DZ twins' views on the categorization of infertility and the permissibility of using medical technologies to overcome it. Older respondents were more likely to regard medical treatment of infertility as interfering with nature and/or with God's will.

Views on parents selecting their children's genes prior to birth

Almost half of our respondents (49%) believed that 'parents should have the right to select their children's genes before birth to eliminate life threatening genetic diseases' (35% disagreed; Table 3, statement D). However, regarding parents selecting their children's genes before birth to determine traits such as height, weight and intelligence, almost 9 in 10

(88%) believed that parents should not have the right to do so [with less than 1 in 10 (7%) believing that they should; Table 3, statement E].

We found significant correlations between respondents' self-assessed degree of religiosity and their responses regarding both statements. Twins with higher religiosity scores tended to be more strongly opposed to a suggested parents' right to select their children's genes to eliminate life threatening diseases prior to birth (statement D; $P < 0.001$) and contested more the right of parents to select their children's genes prior to birth to determine traits such as height, weight and intelligence (statement E; $P < 0.001$). Apart from differences regarding zygosity and age (with older respondents being more opposed to gene selection for enhancing traits), no differences between any other subgroups (zygosity, gender, and absence or presence of biological children) were found.

Views on HRC

When asked whether in the situation of having lost a young child, they would consider the possibility of creating a baby genetically identical to the deceased child, less than 1 in 10 of our respondents overall said they would consider doing so; more than 8 in 10 said they would not (Table 4, statement F). When HRC was suggested to be used 'for medical purposes, e.g. to save the life of an older sibling', opinions were divided with 35% of our respondents in favour of legalizing this possibility and 44% against (Table 4, statement G).

Respondents were similarly divided regarding the statement 'I oppose reproductive cloning as it does not involve the joining of an egg and a sperm' (Table 4, statement H). Whereas 39% agreed with this statement, almost the same number (37%) disagreed, and 24% opted for the 'neither/nor' point 4 on the scale.

Finally, 44% agreed with the statement that 'human cloning should never be allowed', whereas 35% disagreed with this call for a general and permanent prohibition (Table 4, statement I).

Table 3: Views on selecting genes prior to birth

Statement	Reply	Total %	Gender			Zygoty			Biological children			Age Sp	Religiosity Sp
			M %	F %	P %	MZ %	DZ %	P %	Children %	No children %	P %		
(D) Parents should have the right to select their children's genes before birth to eliminate life threatening genetic diseases, if the technologies to do so are available	Strongly agree	24	21	24		24	24		18	25			
	Agree	25	28	25		26	25		29	25			
	Undecided	16	15	16	NS	16	15	NS	18	16	NS	NS	0.103
	Disagree	17	21	17		17	17		18	16			
	Strongly disagree	18	15	18		17	19		17	18			
(E) Parents should have the right to select their children's genes before birth to determine traits such as height, weight and intelligence, if the technologies to do so are available	Strongly agree	4	4	3		4	3		3	4			
	Agree	3	7	3		3	4		3	3			
	Undecided	5	10	5	NS	4	6	NS	5	5	NS	-0.071	0.068
	Disagree	16	24	15		18	15		17	16			
	Strongly disagree	72	55	74		71	72		72	17			

P, chi-square test for linear trend; Sp, spearman rank correlation; NS, not significant; % may not add up to 100 due to rounding.

Significant differences between MZ and DZ twins were found regarding the statement that 'human cloning should be allowed for medical purposes, e.g. to save the life of an older sibling'. MZ twins were significantly more likely to agree with this than were DZ twins (statement G; $P < 0.05$). We found correlations between the degree of religiosity of our respondents with their views regarding all four statements pertaining to HRC (statements F–I). The more religious respondents were, the less likely they were to consider replacing a deceased child with another one genetically identical to that child (statement F; $P < 0.001$), and the less they agreed that cloning to save the life of an older sibling should be allowed

(statement G; $P < 0.001$). In addition, increasing religiosity was significantly associated with greater opposition to cloning 'as it does not involve the joining of an egg and a sperm' (statement H; $P < 0.001$), and with a tendency to agree that human cloning should never be allowed (statement I; $P < 0.001$). Pertaining to gender, regarding the claim that human cloning should never be allowed (statement I), women tended to hold more 'extreme' views than men, whether they strongly agreed (29% of women versus 20% of men) or strongly disagreed (18% of women versus 15% of men). A significant correlation was found between age and greater hesitance to consider using HRC to "replace" a

Table 4: Views on human reproductive cloning

Statement	Reply	Total %	Gender			Zygoty			Biological children			Age Sp	Religiosity Sp
			M %	F %	P %	MZ %	DZ %	P %	Children %	No children %	P %		
(F) If I lost a young child and I had the possibility to create a baby genetically identical to him/her, I would consider doing so	Strongly agree	4	5	4		4	4		2	4			
	Agree	5	11	5		5	5		6	5			
	Undecided	8	11	8	NS	9	8	NS	9	8	NS	-0.037	0.066
	Disagree	13	19	12		14	12		13	13			
	Strongly disagree	69	54	71		68	71		70	70			
(G) Human cloning should be allowed for medical purposes, e.g. to save the life of an older sibling	Strongly agree	15	17	15		16	14		14	16			
	Agree	20	24	20		21	20		19	21			
	Undecided	21	29	21	NS	21	20	<0.05	21	21	<0.01	NS	0.119
	Disagree	19	23	18		17	20		21	17			
	Strongly disagree	25	16	26		25	26		26	25			
(H) I oppose human reproductive cloning as it does not involve the joining of an egg and a sperm	Strongly agree	23	16	24		23	24		20	24			
	Agree	16	17	16		17	15		16	16			
	Undecided	24	26	24	NS	24	24	NS	27	24	NS	-0.072	-0.118
	Disagree	17	25	16		17	17		19	16			
	Strongly disagree	20	16	20		19	20		18	20			
(I) Human cloning should never be allowed	Strongly agree	28	20	29		28	29		26	29			
	Agree	16	17	16		17	16		18	17			
	Undecided	21	23	21	NS	21	20	NS	22	20	NS	NS	-0.119
	Disagree	17	25	16		17	17		18	16			
	Strongly disagree	18	15	18		17	18		16	18			

P, chi-square test for linear trend; Sp, spearman rank correlation; NS, not significant; % may not add up to 100 due to rounding.

deceased child. Similarly, older respondents were more likely to agree that they opposed HRC, as it does not involve the joining of an oocyte and a sperm (statement H; $P < 0.001$). Finally, respondents with biological children were significantly more likely to agree that HRC should be allowed for medical purposes, e.g. to save the life of an older sibling, than those without biological children (statement G; $P < 0.01$).

Discussion

Although our data confirm, to some extent, previous research into public attitudes towards new medical technologies, it generates a number of new insights and raises some new questions. For example, it has been argued in the past that many people deem the use of medical technologies to ‘treat’ a condition that is not seen as a disease as interfering with nature, or as generally immoral (Milner *et al.*, 1999; Katz *et al.*, 2002; Iredale *et al.*, 2003). In this light, it is an interesting and somewhat counter-intuitive finding that whereas more than half of our respondents (54%) did not classify infertility as a disease (statement A), neither did they—by a majority—think that using medical technologies to treat infertility is tantamount to interfering with nature or with contradicting God’s will (only 13% and 10%, respectively, believed that it does; statements B and C, Table 2). This suggests that our respondents do not appear to deem it ‘wrong’ to use medical technology to treat a condition that they do not see as a disease. Although we did not establish how our respondents classify infertility, our findings suggest that they did, by majority, regard procreation as an important human need.

A recent nationwide survey (respondents were 18 or older) on assisted reproduction in the UK represents an interesting comparison, although differences in the wording of the questions render the results not directly comparable with our data. Over half (57%) of 4012 respondents in that survey agreed that modern science should help infertile people to have a child of their own (YouGov, 2006: 5). In addition, YouGov (2006: 7) also found that 70% said that alternatives to fertility treatments should be promoted more widely. Only 55% of their respondents agreed that all people have a right to have a child of their own (YouGov, 2006: 5).

In our survey, zygosity did not correlate with attitudes regarding any statement except for regarding the permissibility to use HRC for medical purposes (statement G), with MZ twins being significantly more positive about this scenario. A possible explanation for this difference could be that MZ twins have practical experience with being genetically identical; they have a stronger awareness of the fact that people’s personalities and identities are not exclusively determined by their genes (Prainsack and Spector, 2006). Thus, while non-identical twins, when confronted with the term ‘genetically identical’, might draw upon media coverage and fiction on cloning (where ‘clones’ are often portrayed very negatively as ‘carbon copies’ of their ‘originals’), identical twins can draw upon their own experience as genetically identical but nevertheless very individual people who therefore are less negatively prejudiced about genetic sameness. They know that simultaneity of different identities is possible: one can be both

genetically identical to somebody else as well as be a normal individual. Although this would be a plausible explanation, it has yet to be supported or challenged by findings of systematic research on this issue.

Our data confirm some prior findings into attitudes of the general public (not restricted to twin populations). First of all, this is true for a generally negative attitude towards legalizing HRC. In our survey, 44% agreed with the statement that ‘human cloning should never be allowed’ (statement I), whereas 35% disagreed. Similarly, Sturgis *et al.* (2004: 130, $n = \sim 2500$ adults aged 18+), in their British Social Attitudes Survey, found that ‘just under four in 10 people think such reproductive cloning should be allowed, while just under half think it should not’. It should be noted that the explicit medical context in which HRC was presented to respondents in Sturgis *et al.*’s survey (an infertile young couple are offered ‘treatment’ by means of HRC) might have generated more positive responses than in our survey. Interestingly, this was not the case.

Calnan *et al.* (2005) reported data from questionnaires sent to a random sample of individuals aged 18 and above in England and Wales ($n = 1187$), in which attitudes to a hypothetical cloning scenario were measured. Similar to Sturgis *et al.*’s survey, a young couple struggling with infertility were offered a clinical trial of human cloning to create a child. Only 12% of the respondents said that the couple should participate in the trial. About 68% said they should not, and 19% said they did not know. As the question did not concern the potential legal permissibility of the procedure, but rather what the respondent would advise the couple in a concrete scenario, the data are not easily comparable to questions which focus on legal permissibility of HRC, such as ours. Nevertheless, similar to our findings, a clear majority of respondents in Calnan *et al.*’s survey opposed HRC.

Our results also support previous (qualitative and quantitative) research findings suggesting that the determination of genetic traits (entailing either the selection of particular traits or the whole genome, such as in HRC) prior to birth is seen as more acceptable when it serves medical objectives in the strict sense. When such an intervention is seen to ‘enhance’ a certain status or ability, rather than ‘treat’ a medical condition in the strict sense, public resistance is higher (Prainsack and Spector, 2006; Sturgis *et al.*, 2004; Nisbet, 2004; Shepherd *et al.*, 2007). Regarding our statements on HRC, however, the relatively large percentages of respondents who neither agreed nor disagreed with the statements offered to them (one in five opted for the ‘neither/nor’ point 4 on the scale when asked whether human cloning should be allowed for medical reasons; when asked whether they opposed human cloning because it does not involve the fusion of oocyte and sperm, and when asked whether human cloning ‘should never be allowed’) seems to indicate that our respondents were willing to consider certain options rather than just ‘applying’ ready-made and strong opinions. It might be difficult for many to answer abstract questions without receiving more information on the concrete circumstances of the situation in which such a dilemma would come up.

Our findings regarding the positive correlation between the degree of religiosity of respondents and more restrictive

attitudes towards medical technologies support the commonly held belief that religious Christians are more reluctant than secular Christians and other, non-Christian, denominations to accept the use of medical technology in the field of reproduction (Evans, 2002). Although we did not carry out any systematic research on this topic specifically, we have reasons to believe that opposition to HRC is less strong in non-Christian contexts, especially in those where 'playing God' is not seen as a reprehensible act as such (Bainbridge, 2003; Barnoy *et al.*, 2006; Prainsack, 2006).

Our data support findings of previous research on public attitudes towards biotechnologies, suggesting that men tend to be less sceptical of medical technology than women (Napolitano and Ogunseitan, 1999; Barnoy *et al.*, 2006; Shepherd *et al.*, 2007). In a Christian context, a possible explanation for this would be that on average, women are more religious than men.

The fact that female twins, on the other hand, were more likely than male twins in our study to classify infertility as a disease could be linked to the biological circumstances of reproduction. Because women's bodies are more invested in reproduction than male bodies, it could be argued that women have a stronger sense of feeling 'ill' if reproduction fails (Greil *et al.*, 1988).

Our findings that older respondents tend to hold more negative views on HRC are in accordance with findings of other studies (Barnoy, 2006; Shepherd *et al.*, 2007). The greater emphasis which older respondents seem to place on gamete fusion in reproduction is a topic in need of further research. A possible explanation is that older cohorts hold a more traditional normative ideal of reproduction (they prefer as little technological intervention as possible).

Our survey did not examine the reasons for why twins who had their own (biologically related) children were less likely to qualify infertility as a disease. More research is needed on the reasoning and rationales underlying the classification of infertility as a disease (as well as on how both 'infertility' and 'disease' are conceptualized in 'lay' populations; Hashiloni-Dolev 2006).

With regard to the finding that respondents with biological children were more likely to accept HRC for medical purposes (e.g. to save the life of an older sibling), it is plausible to be assumed that respondents who do have children find the thought of losing them to a disease so painful that they are more likely to accept HRC as a possible remedy than people for whom this statement remains a more abstract topic.

Limitations of the study

The medical contextualization of our statements about HRC is likely to have yielded more positive responses to the idea of HRC than it would have been the case if we had examined attitudes towards HRC in the context of governmental control and dictatorship. Our mentioning of gene selection prior to birth in the context of HRC, on the other hand, can be expected to have counterbalanced some of the 'positive' effects on attitudes, as the vast majority of twins saw genetic manipulation for the purpose of traits such as height, weight and intelligence as clearly negative. Similarly, as mentioned above, the limitation of our sample to Caucasian (and therefore predominantly

Christian) populations might have generated slightly more sceptical responses.

Conclusions

Our results suggest that the public sees HRC in a more context dependent manner than presumed previously. Although there is widespread opposition against the use of gene selection prior to birth as well as HRC for purposes that are seen as mere enhancement of the genetic make-up with no medical problem present, a considerable percentage of respondents in various surveys seems to be willing to consider the use of HRC when it serves a medical objective of some sort. Apart from merely calling for further research on this topic, future public attitudes surveys on new medical technologies should use qualitative methods for an exploration of the meanings that respondents employ when they respond to abstract questions.

The fact that responses of MZ twins differed from responses of DZ twins only with regard to HRC (MZ twins were significantly more positive towards using HRC for medical purposes), suggests that although the attitudes of twins towards new reproductive technologies and gene selection do not vary with zygosity, the practical experience that MZ twins have with genetic sameness (as they share 100% of their genes) renders them less likely to object to cloning solely on the basis of the creation of genetically identical individuals.

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