The authors present a quantitative content analysis of biotechnology-related coverage appearing in the New York Times *and* Newsweek *between 1970 and 1999, examining patterns of media attention and evaluating the source impact of various political and social actors on the themes, frames, and tone of coverage. Although media attention to biotechnology steadily increased across the 1980s and most of the 1990s, it has been highly episodic, peaking and plummeting in response to major scientific announcements. Even in its peak years of coverage, biotechnology still rests rather modestly on the overall media agenda compared with other issues related to science, technology, or popular culture. The character of biotechnology-related coverage has been overwhelmingly positive, with heavy emphasis on the frames of scientific progress and economic prospect. A departure from this trend only occurs in correspondence to the late 1990s debate over cloning, as a greater media emphasis on ethics and controversy emerges.*

Biotechnology and the American Media

The Policy Process and the Elite Press, 1970 to 1999

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For several millennia, humans have been using biological technology, or "biotechnology," to alter their surroundings and environment, embracing

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techniques including cheese making and brewing, as well as plant and animal breeding. Only beginning in 1970 did a "new" biotechnology emerge, involving a more precise (and sometimes more powerful) direct manipulation of living organisms at the genetic level that has resulted in a diversity of applications. Specific to the health sciences, examples of these applications include reproductive techniques such as in vitro fertilization,[1] research involving human embryos and stem cells, new and more potent biological weapons, research involving gene therapy and predictive medicine, and genetically engineered vaccines and pharmaceuticals. Applications specific to agriculture involve novel or more resistant genetically modified plants and bacteria that overexpress or underexpress a gene or include new genes, as well as genetically modified or cloned animals that are designed to increase food production, manifest desired traits, or serve as biofactories to produce pharmaceuticals and organ transplants. The new biotechnology has even sparked debate and claims specific to human cloning, including the creation of vain self-replicas, the hoped for "resurrection" of a lost child, or the harvesting of organs and bone marrow from cloned tissue.

Guiding these biotechnology-related advances have been the shared interactions among scientists, policymakers, industry, and other political or social interests (Cozzens and Woodhouse 1995), with these actors engaged in a power game over control of biotechnology's applications and benefits (Gaskell, Bauer, and Durant 1998). Indeed, modern biotechnology's thirty-year history has been inherently "political," as development has taken place within the larger context of American policy making, a process characterized by a "pressure system" highly restricted to a few interests that often dominate political alternatives, with power emanating from the ability to define or frame issues (Schattschneider 1960).

The media have played an integral, interactive role within this political competition. As we will review in this article, the mass media comprise the principal arena where policy-relevant issues come to the attention of decisionmakers, interest groups, and the public. Not only do the media influence the attention of competing political actors and the public, but the media also powerfully shape how policy issues related to biotechnology are defined and symbolized.

The nature of media coverage then becomes an important subject for study in relation to the development of biotechnology. Yet, only a few systematic surveys of biotechnology-related media coverage in the American context have been carried out. In this article, to redress this gap, we present a quantitative content analysis of biotechnology-related coverage appearing in the *New York Times* and *Newsweek* between 1970 and 1999. In our study, we measure the visible source impact of various social and political actors, the tone of

coverage, the main themes or issues covered, and the main frames featured and compare these measures to key political and economic events. In adopting this approach, our results are not only of interest to specialists studying the political and social history of biotechnology but also of interest to researchers in media studies, sociology, or political science who share a more general focus on media agenda-building and frame-building processes.

The Policy Process and the Press

In America's "mediated democracy," the processes and events that take place in the policy sphere and the groups that compete in the political system are not only mirrored (or covered) in the media but also shaped by the media. In most cases, the media's influence comes early on in the policy process, determining what issues will be addressed on the policy agenda (Kingdon 1984; Linsky 1986).[2] At this early stage in the policy process, the best political strategy, where the influence of decisionmakers can be direct, is one in which an interest group manages to control the scale of conflict on an issue, keeping decision making behind closed doors away from public or media attention (Bachrach and Baratz 1970; Cobb and Elder 1971), thereby managing conflict before it starts (Schattschneider 1960). At the root of these "nondecisions" or "uncontroversies" that are kept from public view are structural or cultural factors that suppress noticeable disagreement among policy actors (Bachrach and Baratz 1970; Cozzens and Woodhouse 1995). Often the result is a "mobilization of bias," or a pattern of policy outcomes that systematically and consistently benefit certain interests over others (Bachrach and Baratz 1970; Schattschneider 1960).

If an interest can control media and public attention to an issue, then it has succeeded in controlling the media and public agenda. Moreover, when an issue does appear in the media, if interests can define their stand as well as the alternatives available for discussion, then they have "framed" the situation in more winnable terms, delimiting the arguments the opposition can make and screening them off from participation (Berkowitz 1992). These media "frames" offer a central organizing idea or story line that provide meaning to an unfolding series of events, suggesting what the controversy is about, and the essence of an issue (Gamson and Modigliani 1989). Frames also serve as working routines for journalists that allow journalists to quickly identify and classify information, packaging it for audiences. These organizing devices are especially useful when journalists are thrust into unfamiliar territory. Framing strategies, however, can lead to "pack journalism," with journalists adopting similar frames across coverage (Gitlin 1980).

Once an issue is framed or characterized early on in a debate by the media, it can be very difficult for policymakers to shift the image of the issue to another perspective (Linsky 1986; Schön and Rein 1994). Recognizing the importance of media coverage in influencing policy outcomes, various competing interests or political actors often lobby the media to shape the attention and emphasis of coverage in a way that marshals support for their positions. Within this "media agenda-building" process (Berkowitz 1992) and "media frame-building" process (Scheufele 1999), competing interests operate as news sources, supplying strategically packaged news items and story information to journalists. Indeed, most stories are source generated (Gandy 1982), with some estimates placing half or more of newspaper stories as source originated (Sigal 1973; Soloski 1989).

Not only is news likely to be source driven and source framed, but also certain types of interests are likely to be more influential in controlling and framing news than others. In general, government-affiliated interests are most effective at influencing news, often because their actions are considered newsworthy events. Journalists also come to rely on policymakers for "routine channel" information, or news that fits organizational deadlines or demands (Tuchman 1978). Often this type of news is based on press conferences, press releases, or official proceedings (Sigal 1973).

Another type of influential source is industry. By providing the media with expensive information subsidies—including video releases, well-crafted Web sites, and materials produced by public relations professionals—industry interests are often able to make it easier for journalists to file their story on time and efficiently (Berkowitz 1992). Industry may also rely on paid direct media access in the form of political advertisements or through the direct financial support of independent think tanks that produce experts used as objective sources (Danielian 1992). Other sources—including lawyers, doctors, celebrities, and scientists—wield media influence because of their strategic location in the social or economic structure and their perceived social legitimacy (Cobb and Elder 1971). Over the past fifteen years, consumer, environmental, and "public interest" organizations have increasingly become more professionalized and hierarchical, adopting tactics similar to industry, including paid political ads, in-house experts, and public relations professionals (Lichter and Rothman 1999). However, their still limited resources in comparison to industry force these groups to rely more heavily on personal contacts in the media (Danielian 1992).

Competing interests frame issues in ways that strategically advantage their political positions, emphasizing certain aspects of an issue over other considerations, influencing estimations of the causes, consequences, and solutions to a policy problem. If news coverage is heavily source dependent

and a few sources are advantaged in the competition to shape media's agenda and frames, then the character of news coverage of any one issue is likely to be limited in scope and focus to the selective framing provided by the sources on which journalists most heavily depend (Miller and Reichert 2000). For most interests, their final goal is to make their perspective appear to be "official policy" in news coverage. By successfully triggering such processes as a spiral of silence whereby voices of dissent are increasingly driven out of news coverage in deference to a perceived majority perspective (Noelle-Neumann 1984; Scheufele and Moy 2000), hegemonic media coverage can result. This state of hegemony is characterized by media coverage that constructs only one viewpoint as legitimate, or media coverage that heavily delegitimizes dissenting perspectives (Gitlin 1980; Hallin 1987; Miller and Reichert 2000).

Examples related to biotechnology. Several accounts of biotechnology have characterized the influence of sources on the media agenda-building and frame-building processes. In one case, during the recombinant DNA (rDNA) debates of the mid 1970s, when scientists first called attention to possible risks associated with rDNA technology, they framed the issue in a series of public letters to *Science* as a narrow question of laboratory-based technical risk, best resolved as an internal matter among scientists. At the 1975 Asilomar conference, scientists convened debate behind closed doors, issued tight controls on media reports (Altimore 1982; Rogers 1977; Wade 1977), and formulated recommendations on rDNA research most favorable to their interests (Krimsky 1982). Later, during open regulatory and congressional debate, the emphasis on technical risks as initially framed by scientists dominated legislative and regulatory considerations. A competing frame offered by other interests that emphasized the broader ethical and social implications of rDNA technology, including public participation in decision making and the consideration of possible uses directed toward genetic engineering, was given considerably less attention and legitimacy (Krimsky 1982, 1991).

Although in past surveys scientists have indicated that their chief reason for engaging the media is public education, other more self-serving motivations, including political interest or promotion of funding opportunities, are likely to be underreported (Peters 1999). Indeed, scientists are often "sources with a mission" (Nelkin 1995), especially when they perceive a threat to their interests. In the rDNA debate, scientists perceived that what was at stake were the core values of science, including freedom of inquiry, self-directed research, and peer review (Krimsky 1982). There was strong sentiment among scientists that by being the first to call attention to possible risks of rDNA research, even as they framed the matter in a technical light, they had set in motion a political process and that scientists needed to deliver a strong

political message to keep debate in check (Turney 1998). In the latter half of the 1970s, as efforts toward local control and local regulation of research took place among approximately two dozen local or state governments nationally, with about half passing some form of regulation, scientists began "to close ranks." Those scientists who had previously raised concerns about research shifted their position to form a scientific consensus, arguing that the risks to scientific autonomy now far outweighed any risks related to rDNA research (Krimsky 1982). Scientists sharpened their focus on technical risk and delegitimized the public's reaction as a case of mass hysteria or psychosis that was part of a growing "anti-science" movement (Turney 1998).

Scientists are not the only powerful interest to attempt to shape policy outcomes through influence of media coverage. In an example of industry influence, during the early 1980s, media coverage was characterized by one-sided promotion of the biotechnology industry, with the press "held captive" by industry publicity. Every new scientific finding was heralded by media reports as a major new cure or agricultural application. The tone of coverage spurred continued investment from capitalists and boosted public confidence in a new breed of "blue chip" stocks (Krimsky 1991). In the early 1990s, a decade after the first industrialization efforts, only fifteen biotech companies among several hundred had generated positive cash flow, forcing industry again to resort to circumspect press tactics. In several lawsuits, industry interests were accused of using hyperbolic press releases to boost stock prices. They were also accused of failing to disclose important negative information that might be harmful to share prices yet important to investors (Cohen 1992).

Policymakers also work to frame biotechnology strategically, often to the benefit of industry interests. The reason is that policymakers have considered biotechnology development critical to domestic economic growth, international competitiveness, and global security (Krimsky 1991). Some of the most influential government attempts have taken the form of official government studies. In the early 1980s, investor optimism was boosted by a 1984 Office of Technology Assessment (OTA) report that uncritically characterized biotechnology as a possible solution to many of the world's problems, including malnutrition, disease, energy availability, and pollution (OTA 1984). Later in the decade, the OTA released a 1987 national survey that was framed as evidence of heavy public enthusiasm and optimism regarding biotechnology, a tone that was reflected in press accounts related to the survey (Priest 2001). In reality, however, the OTA survey results revealed an American public that was mostly unaware of biotechnology. Others have characterized the results as reflecting a public less enthusiastic than earlier surveys had indicated, with the public supporting more aggressive regulation (Priest 2001).

Beyond official government reports and proceedings, other government actions can define issues related to biotechnology in potentially more subtle ways. In 1987, when the U.S. Patent Office issued the first patent for a multicellular organism, among twenty-one pending applications they chose to inaugurate the "Cancer mouse," a genetically engineered lab rodent that could be used in specialized research on breast cancer. The linkage of a divisive issue such as the patenting of life with the symbol of progress toward a cure for cancer had obvious positive media value, especially considering that the pending patent applications that were delayed until after the mouse announcement involved potentially more troubling images of deformed animal chimeras (Krimsky 1991).

One policy analysis points to the cooperative efforts at issue definition between scientists, policymakers, and industry. Plein (1995) asserts that during the 1970s, interests opposed to biotechnology were successful at conjuring images related to biotechnology of environmental risks, social uncertainty, and regulation. However, beginning in the 1980s, industry, policymakers, and scientists working together were able to reframe biotechnology in a positive light. These actors combined as a "collective" voice of shared support, associating biotechnology with popular issues such as local or state economic development and American international competitiveness. They were also successful at discrediting biotechnology opponents as extremists and representing biotechnology opposition as led by just a few radical leaders, including legal "gadfly" and author Jeremy Rifkin.

Although scientists, industry, and policymakers may hold the upper hand in shaping policy debate, other interests may attempt to use the media to increase their own legitimacy, visibility, or importance. In 1971, when bioethicists Willard Gaylin and Daniel Callahan formed the Hastings Center as an institute to promote the study and public discussion of bioethics, both men decided that a focusing event was needed to draw public attention to the bioethics movement and to raise money for the center. Gaylin chose human cloning as the issue that would be most likely to catalyze public concern related to biological research since it symbolized the lure of science, represented the possible negative outcomes of biological research, and fit well with a public aversion to cloning that stretched back to Mary Shelley's *Frankenstein*. Through ties at the paper, Gaylin lobbied the editorial staff of the *New York Times* magazine to provide the forum for his discussion of human cloning. His strategically framed article "The Frankenstein Myth Becomes Reality—We Have the Awful Knowledge to Make Exact Copies of Human Beings" appeared in 1972, bringing national attention to the Hastings Center (Kolata 1998).

A shared culture between journalist and source. The media agenda-building and frame-building process is not exclusively dominated, however, by competing interests and sources. Final coverage is attenuated in part by the routines of journalists and the constraints of media organizations (Gans 1979; Shoemaker and Reese 1996; Sigal 1973). The way journalists and sources view their job and their relationship, therefore, is the result of several levels of forces that are in constant dynamic interaction. These interactions promote a shared culture between journalist and source that guides interaction and sets an unofficial set of ground rules (Berkowitz 1992).

Related to science and biotechnology coverage, past research has highlighted the shared culture between the frequent contributors of science news, science journalists, and their traditional sources, scientists (Nelkin 1995). Science journalists have historically viewed themselves as bridging the divide between the "professions" of journalist and scientist (Lewenstein 1990). As part of this shared culture between journalist and source, the complexity of science stories often leads science writers to favor information sources that are predominantly scientists or intermediary public information officers at universities, research institutes, or corporations, sometimes to the exclusion of other relevant actors. Science writers also tend to rely heavily on routine channels of information within the scientific community, including press releases, professional society meetings, press conferences, science journals, and interviews for story leads (Nelkin 1995), often to the exclusion of other relevant, sometimes contradictory, voices (Greenberg 1997). Despite their claims to journalistic independence, science writers in their reporting tend to reflect the concerns of the scientific community, rather than those of the "public" they often claim to represent (Lewenstein 1995).

In regards to the rDNA debates of the 1970s, science writers have been criticized for not featuring information and commentary from experts in relevant but nonscience fields such as bioethicists studying the social impact and ethical implications of the technology or economists studying industry development. Science writers have also been criticized for failing to include input from members of the general public (Goodell 1986).

Among scientists, those who are university affiliated have been especially influential as sources for biotechnology news. Besides filling a need for experts to gather, sort out, and explain technical information related to biotechnology, university scientists are better for journalists as sources because they are considered objective or neutral in their perspectives (Priest 2001). The unintended result is a likely source-generated pro-biotechnology bias in media coverage since university scientists engaged in biotechnology research are often more positive in their outlook than other university scientists (Lyson 2001; Priest 2001; Priest and Gillespie 2000).

Although scientists are usually the dominant sources in coverage of science and biotechnology, often to the exclusion of other contradictory voices, crises or dramatic focusing events can sometimes create a shift in source influence (Berkowitz 1992). For example, in reaction to the cloning events of 1997, journalistic orientations toward controversy, conflict, and drama served to emphasize the ethical implications of cloning technology, pitting the events and comments of scientists against the reaction of bioethicists, religious leaders, and other social or political actors. The inclusion of these new sources in coverage meant that the ethics of human cloning came to dominate public discussion (Priest 2001).

Changing events can not only shift the balance of source influence, but they can also introduce new frames to a debate that may mobilize or allow access to interests previously not included in the media and policy agenda-building process (Benford and Snow 2000; Gamson and Modigliani 1989; Kingdon 1984). In 1999, after a letter to *Nature* reported evidence that Bt corn may be harmful to the Monarch butterfly, the media for the first time were able to report on a tangible possible threat related to agricultural biotechnology. Opposition interests that had previously been marginalized in coverage emerged as narrators of the agricultural biotechnology controversy, able to provide the media with dramatic images of street theater and protest through mock-ups of "Franken-Tony the Tiger" and "genetically modified" corn flakes, or dancing human butterflies role-playing a Bt-induced death beneath towering stalks of corn. Several interest groups (such as the Union of Concerned Scientists and the Environmental Defense Fund) that employed credentialed experts on agricultural biotechnology became important non-university, nongovernment, and nonindustry sources of technical information (Rissler 2000). Other environmental groups that had been on the periphery of the agricultural biotechnology debate were now lured to the topic, and these groups subsequently devoted increased resources to the issue (Margulis 2000), resulting in increased media and policy lobbying from interests opposed to the technology.

Some issues related to biotechnology have failed to make it onto the elite media's agenda and instead have only received attention from regional or specialized news outlets. The reason is that journalists often favor issues that they consider close to the interests of their readers or viewers (Shoemaker and Reese 1996). In an example of this "proximity" convention influencing media coverage of biotechnology, during the late 1980s and early 1990s debate over the marketing of bovine somatotropin (BST)–produced milk, opposing interests launched intensive propaganda campaigns (Priest 2001). Yet the elite press, including the *New York Times*, paid little attention to the issue, likely considering BST of lesser interest to their broad national

readership. Only at regional news outlets in agricultural states, including Wisconsin and Vermont, did BST-related issues receive prominent coverage (Priest 2001).

In other cases, however, regional media coverage can precede and spark widespread national media attention, which then affects the policy agenda. A clear example of this occurred with the controversy surrounding Dr. Richard Seed. In December 1997, at the end of a year of debate surrounding the possibility of human cloning, Seed announced at a scientific meeting in Chicago that he planned to raise money to open a human cloning clinic. The first media account of Seed's plans to clone humans appeared in the *Washington Times* on 11 December 1997 (Price 1997). Seed's claims did not receive national media attention, however, until 6 January 1998 in an interview with Joe Palca (1998) on National Public Radio. The radio report was followed by next-day coverage appearing in the *Washington Post* (Weiss 1998a). Over the next two days, coverage of Seed's claims appeared in print, television, and radio outlets across the country. Widely viewed as reacting to the sudden and dramatic public attention given Seed's claims, President Clinton in his end-of-the-week radio address urged Congress to pass previously stalled legislation to ban human cloning (Weiss 1998b). By mid-1998, both Republicans and Democrats had introduced legislation into the Senate (Dewar and Weiss 1998).

Previous Surveys of Press Coverage of Biotechnology

As mentioned at the outset of this article, few systematic surveys of media coverage of biotechnology have taken place. In several early qualitative studies, media coverage during the initial years of recombinant DNA development was characterized by a focus on risks and potential threats to public health (Goodell 1980, 1986). However, beginning with the Asilomar conference in 1976, scientists and their institutions began to strategically control media access to information. As critics within the scientific community either reassessed their estimations of risk or were silenced through peer pressure, the character of coverage turned overwhelmingly positive, with few reported voices of dissent (Altimore 1982; Goodell 1980, 1986). In the late 1970s, when industry began to promote biotechnology development, media coverage shifted to an emphasis on breakthroughs and economic benefits, again with few reservations reported. This early coverage of biotechnology has been characterized as highly dependent on the sentiments of the scientists willing to engage the media, with "scientist-proponents" overwhelming the "scientist-critics" (Goodell 1986).

These qualitative assessments are in agreement with the results of an early quantitative study (Pfund and Hofstadter 1981). In 1976 and 1977, during the height of the rDNA controversy, coverage in major newspapers, magazines, and medical or scientific journals regularly carried opinions from dissenting experts and laypersons, but by the end of 1977, reportage of dissident views had dramatically decreased. By 1978, the importance of research benefits received the greatest attention in media coverage, with an emphasis on the potential for breakthrough discoveries, a heavy sourcing of industry-related actors, and a virtual absence of reporting on risks.

In one of the few quantitative content analyses of media coverage of biotechnology, researchers found *Washington Post* coverage through the 1980s was dominated by frames of progress and economic prospect, with dominant themes including health-related applications, basic research, and industry development. Coverage, however, began to turn slightly less positive in the years 1991 to 1996, with an increase in coverage of risks (Gaskell et al. 1999).

Other research has been specific to coverage of agricultural biotechnology. In several studies from the early 1990s, media coverage was characterized as failing to report on elements of political controversy. Journalists depended heavily on information subsidies provided by industry and university public information officers. University sources, in particular, were characterized as emphasizing the positive benefits of biotechnology, resulting in "boosterish" coverage that virtually ignored social, political, environmental, regulatory, or ethical concerns (Beall and Hayes 1996; Priest and Talbert 1994). In a more recent time-series analysis of agricultural biotechnology-related coverage appearing in the *Wall Street Journal*, *USA Today*, and *Washington Post* between 1990 and 1999, media attention among the elite papers gradually increased across the decade, with a jump in attention occurring as of 1997. Media coverage focused more on the risks associated with the technology than the benefits. Also, early in the decade, the media, as a basis for comparison, tended to equate agricultural biotechnology with memorable catastrophic events, such as the nuclear accident at Chernobyl. This trend of contextualizing agricultural biotechnology with references to recent historic catastrophes declined across the decade, only to begin an upward swing again in 1999 (Marks et al. 2000).

Research Questions

The influential and interactive role of the media within the policy process, the many assumptions regarding the nature of press coverage of biotechnology, and the findings of previous research characterizing coverage of

biotechnology underscore the importance of a careful exploration and estimation of the amount and nature of media coverage of biotechnology over the past thirty years. As mentioned at the outset of this article, in the American context there has been little systematic comparison of biotechnology's development with trends in media coverage. And although previous qualitative assessments, case studies, and critical observations regarding biotechnology coverage offer valuable insights, in this article we seek to complement this previous research with a solid quantitative and historical description that sheds light on the underlying media-policy interaction.

Due to the limited availability of previous quantitative research characterizing the nature of media coverage of biotechnology, and in light of somewhat conflicting findings, we decided to base the research in this article on a set of relatively narrowly defined research questions instead of hypothesizing specific media trends:

Research Question 1: What has been the level and nature of media attention to biotechnology?
Research Question 2: What themes related to biotechnology have the media covered?
Research Question 3: What have been the common media frames related to biotechnology?
Research Question 4: What has been the tone of coverage related to biotechnology?
Research Question 5: What sources or actors have been featured in biotechnology coverage?

Method

In exploring the above research questions, we are limited by the availability of data and by research resources. One method for investigating the evolving nature of media coverage in relation to the policy process and its competing interests involves the comparison of source information subsidies with media coverage outcomes, tallying the proportion of news releases or other information subsidy efforts that are either covered or discarded by the media (Berkowitz 1992). However, in the present study, spanning thirty years of media coverage, most source materials are difficult to obtain or are unavailable. Instead, we chose to investigate final press coverage as the outcome of the underlying media agenda-building and frame-building process. Our "visible source impact" approach (Berkowitz 1992) focuses on the actors mentioned or featured in articles, the tone of coverage, and the dominant frames and themes exhibited. In this approach, our findings can provide strong

indicators of the most influential sources and interests that have shaped media coverage over the past thirty years. The content analysis presented here involves analysis of various types of data collected between 1998 and 2000, as part of an ongoing coordination with a European Union (EU) study of biotechnology coverage appearing in several European countries (see Durant, Bauer, and Gaskell 1998). Due to differing keyword and sampling strategies, however, our present study does not represent an exact replication of the EU research.

We examined biotechnology-related coverage from the *New York Times* and *Newsweek* appearing between 1970 and the end of 1999.[3] Coverage appearing in the opinion-leading publications such as the *New York Times* or *Newsweek* is likely to represent the dominant tone of coverage in the United States. This choice to focus on the elite media builds on what other media analysts have observed: stories tend to spread vertically within the news hierarchy, with editors at regional news outlets often deferring to elite newspapers and newswires to set the national news agenda (Gitlin 1980). (This trend, however, does not always hold; see, for example, the earlier discussion of BST coverage.)

For this study, we adapted measurement rules used by the EU-funded study of print coverage of biotechnology across ten EU countries (Durant, Bauer, and Gaskell 1998). The rules allowed for measurement of both relatively manifest, objective article content as well as more latent and interpretive content such as themes, frames, and main references to actors.

Measurement of themes provided an indicator of the type of biotechnology research or the related economic, political, or social developments featured by journalists. Coders chose up to three main themes per article. Frames, as defined earlier, provided a second main measure of latent content. Coders chose one main frame per article. Table 1 outlines a typology of frames applicable to biotechnology used in the current study. This typology was adapted from the EU project (Durant, Bauer, and Gaskell 1998) and originally was developed in part by Gamson and Modigliani (1989). Other latent measures included whether the article mentioned biotechnology-related benefits and/or biotechnology-related risks and whether an article reported on controversy. We also included a measure of the main featured actors or sources in an article, with coders choosing up to two actors per article.[4]

Results

Overall press attention, 1970 to 1999. Figure 1 indicates that despite the rDNA debate of the 1970s, developments related to in vitro fertilization, and

TABLE 1
A Framing Typology for Biotechnology

Progress: celebration of new development, breakthrough; direction of history; conflict between progressive/conservative-reactionary
Economic prospect: economic potential; prospects for investment and profits; R&D arguments
Ethical: call for ethical principles; thresholds; boundaries; distinctions between acceptable/unacceptable risks in discussions on known risks; dilemmas. Professional ethics.
Pandora's box: call for restraint in the face of the unknown risk; the opening of flood gates warning; unknown risks as anticipated threats; catastrophe warning
Runaway: fatalism after the innovation; having adopted the new technology/products, a price may well have to be paid in the future; no control any more after the event
Nature/nurture: environmental versus genetic determination; inheritance issues
Public accountability: call for public control, participation, public involvement; regulatory mechanisms; private versus public interests
Globalization: call for global perspective; national competitiveness within a global economy; opposite: splendid isolation

NOTE: Framing typology is adapted from Durant, Bauer, and Gaskell (1998) and originally was developed in part by Gamson and Modigliani (1989).

false claims or predictions related to human cloning, the *New York Times* and *Newsweek* paid limited attention to biotechnology. The major peaks in that decade's limited coverage occurred in 1975, corresponding to the Asilomar conference and related events, and in 1977, when Congress held hearings and introduced legislation related to rDNA regulation. In 1980, only as industrial development of biotechnology began did media attention to biotechnology increase, gradually rising across the 1980s, peaking in 1988, then falling sharply in 1989 with the stock market crash and a temporary halt in industry growth. In 1990, coverage began to increase again along with renewed industry development. Coverage peaked in 1992 when concern arose over possible overvaluation of biotech stocks, with most companies yet to turn a profit. Media attention declined in 1993 but increased again in 1994 with market introduction of BST and the Flavr Savr tomato and fast growth in biotech stocks. Media coverage dipped during the mid-1990s but peaked again in 1997 with the announcement and debate surrounding cloning. Media coverage slightly decreased in 1998, then fell sharply again in 1999.

It is important to keep in perspective the relative amount of media attention to biotechnology in comparison to the total universe of media coverage. At its peak levels of coverage in 1992 and 1997, a biotechnology-related article appeared in only about one out of every three daily editions of the *New*

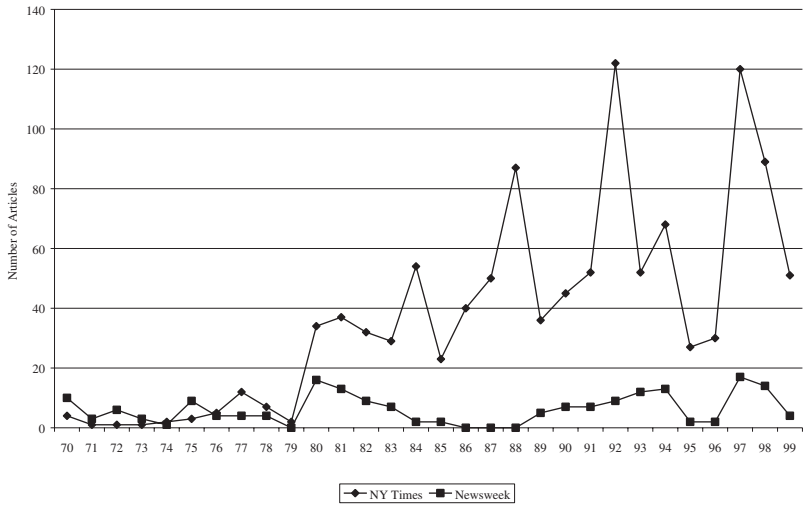

Figure 1: Elite Press Attention to Biotechnology, 1970 to 1999
NOTE: The population of articles appearing in the *New York Times* and *Newsweek* are shown here, based on a keyword search of the Lexis-Nexis Universe. All articles that contained in the headline or the lead paragraph any of the key words or parts of key words "biotech," "clone," "cloning," "genetic engineer*," "gene manipulat*," "gene technolog*," "gene therap*," and "recombinant DNA" were selected.

York Times and only about one out of every three weekly editions of *Newsweek*. In 1995 and 1996, twenty-five years after modern biotechnology's invention, the *New York Times* featured the technology in only one out of every twelve daily editions.

These estimations, however, are averages across a total year. Media attention to an issue is rarely, if ever, equally distributed across time; instead, media attention to biotechnology has been episodic, clustered around key focusing events or source actions,[5] meaning that several articles could appear in one edition of the *New York Times*, or several articles could appear across just a few days or a period of a few weeks. In these clusters of media attention—for example, following the 1997 Dolly announcement—biotechnology is likely to ride high on the overall media agenda in comparison to other newsworthy items.

Evidence indicates that the "birth" of Dolly was considered by journalists to be a major news agenda item. In reaction to the London-based *Observer's* break of the *Nature* press embargo, the *New York Times* ran a late edition article on Dolly, with placement on the right-hand side of page one, indicating

the top story of the day (Kolata 1998). The week following the Dolly announcement, both *Newsweek* and *Time* ran cover articles featuring the story.[6] At the end of the year, in the annual *Associated Press* poll of newspaper editors, Dolly was ranked as the fifth most important story of 1997 (Boorstein 1997).

If biotechnology can sometimes be prominent within a day's, week's, or month's news, biotechnology-related issues could then subsequently go uncovered for an extended period of time until another focusing event or source-influence brings biotechnology back onto the media agenda. When we took a closer look at the frequency of biotechnology-related coverage across months for the years 1997, 1998, and 1999, we found an unequal and episodic pattern of coverage. In February and March 1997, media attention to biotechnology peaked with the Dolly announcement and the ensuing public debate over cloning. In June, media attention peaked again as President Clinton and Congress announced plans for cloning legislation. In January 1998, with the claims of Dr. Richard Seed, media attention returned again to biotechnology, representing the greatest level of coverage for the year. In 1999, media attention rose in June in response to the *Nature* Bt corn study, as well as in October and November in relation to the death of gene therapy patient Jesse Gelsinger and the FDA public comment hearings on genetically modified (GM) agriculture that sparked protests in major cities.

In a final comparison that places media attention to biotechnology in context with media attention to other public affairs issues or other issues related to science and technology, we ran article frequencies from the *New York Times* for various topics covered in 1997. Table 2 indicates that biotechnology received greater or equal attention in the elite press than several events in 1997 that the media considered top stories, such as Mars Pathfinder, Heaven's Gate, campaign finance reform, or the birth of septuplets. However, other technological or scientific issues received far greater attention, including the Internet, nuclear energy, satellite communications, cellular phones, microchips or microprocessors, and climate change. Other popular culture events such as the deaths of Princess Diana and Mother Teresa also received greater attention than biotechnology, as did the debate over assisted suicide, the Timothy McVeigh trial, and several major political issues. These results indicate that even at its peak levels of attention, biotechnology does not reside at the top of the media's agenda in comparison to other major news items, even among other technology-related developments.

Coverage content, 1970 to 1979. In Table 3, early applications of biotechnology featured in press coverage reflect the 1970s debate over rDNA technology and the related potential risk of microorganism release. However, the

TABLE 2
Topical Media Attention, 1997: Issue or Topic with Number of Related *New York Times* Articles for 1997

Internet, 1000+	Beatles or Rolling Stones, 139
Federal Reserve, 892	Heaven's Gate, 127
Nuclear energy, 458	Campaign finance reform, 124
Assisted suicide, 446	**Biotechnology, 120**
Hurricanes or monsoons, 427	EPA air pollution regulations, 111
Climate change, 252	*Titanic*, 110
Whitewater, 241	Solar power or energy, 86
Gun control, 234	Steven Spielberg, 82
Cellular or mobile phones, 213	Mars Pathfinder, 75
Timothy McVeigh trial, 203	HDTV, 67
Mir Space Station, 201	Alternative medicine, 66
Microchips or microprocessors, 195	Breast implants, 58
Welfare reform, 183	Mammograms, 57
Satellite telecommunications, 182	Hubble Telescope, 54
Tobacco lawsuits, 181	Septuplets, 45
Princess Diana, 174	Electric-powered cars, 39
Space shuttle, 173	Alien abduction, UFOs, Roswell, NM, 30
Mother Teresa, 151	Endangered species, 24
Tax reform, 143	Human Genome Project, 16
Earthquakes, 139	

SOURCE: Lexis-Nexis Universe index of *New York Times* for 1997.
NOTE: The issues chosen for comparison with biotechnology are derived in part from the top ten stories of 1997 as indicated by the end-of-the-year *Associated Press* poll of newspaper editors, including (1) the death of Princess Diana; (2) the Timothy McVeigh trial; (3) the death of Mother Teresa; (4) the economic boom (represented here by articles related to a major economic actor, the Federal Reserve, and the Internet); (5) the announcement of Dolly and resulting cloning debate; (6) the birth of septuplets; (7) the tobacco lawsuit settlement; (8) Mars Pathfinder; (9) campaign finance reform–related scandals, including Asian donors and the Lincoln Bedroom; and (10) the Heaven's Gate cult suicide (Boorstein 1997). Other issues, either related to science and technology or to popular culture, were chosen unsystematically and reflect the authors' estimations of major 1997 events or trends.

Lexis-Nexis search terms for each of the issues displayed in Table 2 include "internet," "federal reserve," "nuclear energy or nuclear power or atomic energy or atomic power and/not weapon or missile or bomb," "assisted suicide," "hurricanes or monsoons," "global warming or climate change or greenhouse gas or greenhouse effect," "whitewater and Clinton," "gun control," "cellular phones or mobile phones," "Timothy McVeigh," "Mir Space Station," "microchips or microprocessors," "welfare reform," "satellite and telecommunications," "tobacco lawsuits," "Princess Diana," "Space Shuttle," "Mother Teresa," "tax reform," "earthquake," "Beatles or Rolling Stones," "Heaven's Gate," "campaign finance reform," "biotech* or clone or cloning or genetic engineer* or gene manipulat* or gene technolog* or gene therap* or recombinant DNA," "EPA and air pollution and regulation," "solar energy or solar power," "Mars Pathfinder," "high definition television or HDTV," "alternative medicine or complementary medicine," "breast implants," "mammograms," "Hubble telescope," "septuplets," "electric cars or electric powered cars," "alien abduction or UFOs or Roswell New Mexico," "endangered species," and "human genome."

potential of the new gene-splicing techniques also brought attention to applications still in development, including gene therapy, predictive medicine, and DNA research in general. There was also early attention to gene mapping and the use of DNA in genetic fingerprinting related to crime.

As part of coverage during the 1970s, in vitro fertilization was also featured prominently. Coverage included a heavy focus on the themes of legal regulation in the second half of the decade as Congress, local communities, and regulators debated the safety and risks of rDNA research. Voluntary regulations, ethical issues, and, to a lesser extent, economic prospects were also featured but far less prominently. General safety and risk were given prominent attention in the first half of the decade but decreased in prominence in the latter half of the 1970s. Local community risk, laboratory-related risk, and environmental risk were given less coverage. With the threat of environmental release, biodiversity was also given attention but not prominently. Public opinion emerged as a theme in the second half of the decade as policy debate ensued but was not given prominence.

Table 4 indicates that the dominant frame across the decade was scientific progress, with only a few articles incorporating an ethical, public accountability, or economic prospect frame. Nearly a quarter of the articles appearing during the 1970s were assessed by coders as not featuring an applicable frame, a trend that decreased in years to come, possibly as journalists and competing interests began to develop routine framing devices for an emerging technology, with alternative considerations related to biotechnology never reaching the media agenda.

Table 5 indicates that mention of benefits of the technology far outweighed the mention of risks across the decade. Reporting on controversy slightly increased in the second half of the decade as public debate over rDNA developed, but controversy was still only featured in less than half of biotechnology-related articles.

In regards to the most prominent actors or sources featured in coverage during the 1970s, Table 6 shows that university scientists dominated coverage. The Department of Health and Human Services (DHHS) and the National Institutes of Health (NIH), the principal federal bodies to deal with the rDNA debate, were also prominent. With the debate over local regulation of rDNA, local and state governments were also featured. Despite their involvement in the debate, our results indicate that other interests, including environmental and religious groups and bioethicists, for the most part were excluded from coverage as featured actors. Table 6 also indicates that many articles did not contain manifest actors or mentioned actors that were not specific to our coding frame. This might include shorter articles on the release of new scientific research that did not mention specific authors or institutions,

TABLE 3
Themes in Biotechnology-Related Coverage, 1970 to 1999

	Percentage of Articles					
	1970-1974	*1975-1979*	*1980-1984*	*1985-1989*	*1990-1994*	*1995-1999*
Applications						
Human cloning	2.9	2.0	2.1	1.2	3.6[a]	41.6[a]
Animal breeding/cloning	0.0	6.0	5.2	9.1	5.2[a]	25.5[a]
Plant breeding	0.0	2.0	6.9	6.2	7.2	5.1
Microorganisms	11.8	16.0	8.7	5.3	5.8	0.7
GMO release, plant field test	0.0	0.0	1.7	8.6	1.0	5.1
Gene therapy	11.8	2.0	3.9	2.1	6.5	19.7
Xenotransplantation	2.9	14.0	3.0	0.4	0.8	2.9
In vitro fertilization/reproduction	5.9	6.0	7.3	8.6	5.4	5.1
Pharms/vaccines	0.0	0.0	11.6	17.3	12.9	12.4
DNA research (general)	29.4	64.0	57.1	42.0	35.7[a]	23.4[a]
Human inheritance	17.6	6.0	16.3	17.7	23.3[a]	3.6[a]
Gene mapping	2.9	0.0	1.5	2.1	4.1	2.5
Diagnosis/predictive medicine	5.9	2.0	7.3	10.7	10.3[a]	1.5[a]
Military, defense	0.0	0.0	0.0	0.4	0.0	1.5
Genetic fingerprinting, crime	8.8	2.0	0.9	1.2	5.7[a]	0.0[a]
Genetic fingerprinting, other	0.0	0.0	0.0	2.5	3.4[a]	0.0[a]
Policy, politics, and economics						
Ethical issues	8.8	4.0	6.0	4.5	30.0	31.4
Legal regulations	0.0	32.0	6.4	8.2	3.9[a]	17.5[a]
Voluntary regulations	5.9	8.0	0.0	0.4	9.8	0.0
Economic prospects	2.9	2.0	21.5	17.3	15.5	13.9
Patenting/property rights	0.0	0.0	13.7	11.1	7.8	8.0
General biotech policy	0.0	2.0	0.0	5.8	0.5[a]	8.8[a]
Insurance issues	0.0	0.0	0.0	0.4	0.8	0.0
Privacy, protection of genetic information	0.0	0.0	0.0	0.0	0.5	0.0
Labeling	0.0	0.0	0.0	0.4	1.3	0.0
Eugenics	2.1	2.0	2.1	0.4	1.0	3.6
Education, genetic literacy	0.0	0.0	0.0	1.2	0.3	2.8
Safety and risks						
General safety and risk	17.6	6.0	16.3	17.7	23.3[a]	3.6[a]
Environmental risk	8.8	0.0	1.7	1.6	0.8	0.0
Local community risk	5.9	6.0	1.3	1.6	0.8	0.0
Laboratory workers	2.9	4.0	0.9	0.0	0.0	0.0
Food risk	0.0	0.0	0.0	0.0	3.1	2.9
Biodiversity	5.9	2.0	0.9	3.7	2.8	2.2
Public reaction						
Public opinion	0.0	6.0	0.9	3.3	2.1[a]	15.3[a]
Fear	5.9	2.0	0.0	0.0	0.0	0.0
Other	2.1	0.0	7.3	4.9	5.9	3.6
Number of articles	34	50	233	243	387	137

NOTE: Coders chose up to three themes per article. Only the most frequently appearing themes are shown here. Independent sample *T*-tests were used to identify significant differences ($p \leq .05$) within specific themes between the periods 1990-1994 and 1995-1999. Significant differences are indicated by paired superscripts. Tests for significance across the years 1970 to 1994 were not necessary as data are derived from a population of articles, rather than a probability sample. GMO = genetically modified organism.

TABLE 4
Frames in Biotechnology-Related Coverage, 1970 to 1999

	Percentage of Articles					
	1970-1974	*1975-1979*	*1980-1984*	*1985-1989*	*1990-1994*	*1995-1999*
Progress	58.8	68.0	74.7	81.5	72.9[a]	39.4[a]
Economic prospects	2.9	0.0	13.7	11.1	14.2[a]	12.4[a]
Ethical	5.9	4.2	1.7	0.8	2.3[a]	21.9[a]
Public accountability	5.9	0.0	0.0	1.2	0.3	8.0
Pandora's box	0.0	2.0	0.0	0.4	0.3	2.2
Runaway	2.9	2.0	0.0	0.4	0.3	2.9
Nature/nurture	0.0	0.0	0.0	0.0	0.3	2.9
Globalization	0.0	0.0	0.0	0.0	0.0	1.5
No frame	23.5	24.0	9.9	4.5	9.6	8.8
Number of articles	34	50	233	243	387	137

NOTE: Coders chose one frame per article. Independent sample *T*-tests were used to identify significant differences ($p \leq .05$) within a specific frame between the periods 1990-1994 and 1995-1999. Significant differences are indicated by paired superscripts. Tests for significance across the years 1970 to 1994 were not necessary as data are derived from a population of articles, rather than a probability sample.

TABLE 5
Tone of Biotechnology-Related Coverage, 1970 to 1999

	Percentage of Articles					
	1970-1974	*1975-1979*	*1980-1984*	*1985-1989*	*1990-1994*	*1995-1999*
Mention risks	30.3	58.3	40.0	42.0	36.4[a]	64.2[a]
Mention benefits	63.6	85.4	47.4	50.2	57.9[a]	80.3[a]
Report controversy	31.3	44.0	27.5	21.6	21.4[a]	67.2[a]
Number of articles	33	48	232	243	387	137

NOTE: Mention of risks and mention of benefits could appear in the same article. Coders were asked to identify the presence or absence of both. Independent sample *T*-tests were used to identify significant differences ($p \leq .05$) within mention of risks, benefits, or controversy between the periods 1990-1994 and 1995-1999. Significant differences are indicated by paired superscripts. Tests for significance across the years 1970 to 1994 were not necessary as data are derived from a population of articles, rather than a probability sample.

the release of a new biotech application or product without mention of industry producer or scientist, or stock reports on the performance of biotech indices and the biotech industry in general without reference to specific industry members.

TABLE 6
Featured Actors in Biotechnology-Related Coverage, 1970 to 1999

	Percentage of Articles					
	1970-1974	*1975-1979*	*1980-1984*	*1985-1989*	*1990-1994*	*1995-1999*
None, not applicable	58.9	34.0	50.6	41.5	51.1[a]	24.1[a]
Other	5.9	4.0	6.4	5.3	7.0[a]	0.0[a]
Government affiliated						
Federal executive, president	5.9	8.0	3.0	7.8	3.6[a]	10.9[a]
EPA	5.9	0.0	1.7	5.8	1.3	0.0
NIH, DHHS	2.9	18.0	11.2	8.6	15.8[a]	5.1[a]
USDA	0.0	0.0	2.6	3.3	1.0	0.7
NSF	2.9	0.0	4.3	9.1	2.8[a]	0.0[a]
Patent office	2.9	0.0	3.9	4.1	2.8[a]	0.0[a]
Congress	0.0	0.0	0.9	0.4	0.8[a]	5.1[a]
Judicial, federal	0.0	2.0	4.3	2.9	6.2[a]	0.0[a]
Local or state government	0.0	10.0	0.0	0.0	0.0	0.7
Ethics committee	2.9	4.0	0.9	1.2	1.0[a]	8.8[a]
Independent review panel	0.0	0.0	0.0	0.4	0.0	0.6
Military	2.9	0.0	0.0	0.0	0.0	0.0
Police	0.0	0.0	1.3	1.6	1.3	0.0
General						
The public	0.0	0.0	0.0	1.2	1.3[a]	28.5[a]
The media	5.9	0.0	0.0	0.0	0.5[a]	17.5[a]
Science or medicine						
University scientist	44.1	70.0	45.5	39.5	40.5[a]	20.4[a]
Institute scientist	0.0	12.0	0.0	7.0	4.9[a]	29.9[a]
Scientific organization (AAAS, etc.)	5.9	2.0	0.0	0.4	1.8	1.5
Physician	0.0	0.0	2.6	4.9	0.0	8.8
Hospitals	11.8	4.0	4.7	4.9	5.7	3.6
Industry						
Producer	5.9	0.0	32.2	32.9	27.1[a]	17.5[a]
Distributor	2.9	0.0	0.0	0.0	0.3	1.5
Industry scientist	0.0	0.0	7.7	0.0	0.0[a]	2.9[a]
Other interests						
Religious	0.0	4.0	0.9	0.4	0.8[a]	4.4[a]
Consumer	0.0	0.0	0.4	2.5	1.0	0.0
Environmental	2.9	2.0	0.0	1.2	1.6	0.0
Agricultural, farming	0.0	4.0	0.0	2.9	1.3	1.5
Bioethicist	0.0	0.0	0.4	0.4	0.5	2.2
Number of articles	33	48	232	243	387	137

NOTE: Coders could choose up to two actors per article. Only the most frequently appearing actors are shown here. Independent sample *T*-tests were used to identify significant differences ($p \leq .05$) for specific actor between the periods 1990-1994 and 1995-1999. Significant differences are indicated by paired superscripts. Tests for significance across the years 1970 to 1994 were not necessary as data are derived from a population of articles, rather than a probability sample. EPA = Environmental Protection Agency; NIH = National Institutes of Health; DHHS = U.S. Department of Health and Human Services; USDA = U.S. Department of Agriculture; NSF = National Science Foundation; AAAS = American Association for the Advancement of Science.

Coverage content, 1980 to 1989. By the 1980s, with the rDNA debate resolved, coverage of microorganisms decreased, though the issue still remained in the press with events surrounding the regulation of the field release of genetically modified organisms. The most prominent themes in coverage, however, were general DNA research, issues related to human inheritance, and predictive medicine. Despite the announcement in 1981 of what was thought to be the first successful cloning of mammals from undifferentiated embryo cells, animal cloning was not featured heavily among total coverage. Also, although in vitro fertilization clinics opened across the country during the 1980s, coverage of this application increased only slightly. One likely reason was that in vitro clinics, in light of the increased targeting of abortion clinics by pro-life interests, deliberately chose to keep a low media profile to avoid drawing attention and controversy (Silver 1998).

In the early 1980s, the emergence of the biotechnology industry brought attention to pharmaceuticals and vaccines, the first biotechnology products to be publicly marketed. Linked to biotechnology's industrial development, economic prospects and agricultural research related to plant breeding were also featured. Economic development brought attention to patenting and property rights. Even though the new federal regulatory framework established in 1986 was a major development in biotechnology's short history, legal regulation received only marginal coverage as a theme during the 1980s, a dramatic departure from coverage of the late 1970s. Other themes related to the regulatory restructuring, including general biotech policy and labeling, also received little attention. Attention to general safety and risk increased during the 1980s, but coverage of specific risks to the environment or to local communities went virtually uncovered as a major theme. The same held true for coverage of public opinion or general public fear of biotechnology.

During the 1980s, scientific progress increased in prominence as the dominant frame related to biotechnology, and economic prospect emerged as a secondary frame. Other alternative ways of framing biotechnology were not found in media coverage. The percentage of articles reporting on controversy dropped dramatically during the 1980s, as the issues associated with biotechnology moved from debate over rDNA risks to focus on industrial and economic development. With a decrease in political debate and reported controversy, fewer articles included direct mention of either benefits or risks, although positive evaluations of the technology still heavily outnumbered negative evaluations.

During the 1980s, university scientists still dominated as featured actors in coverage, as research and development were closely linked to the university-government-industry complex. However, with the economic

development related to biotechnology that began in the 1980s, industry members and, to a lesser extent, industry scientists emerged as a second dominant actor next to university scientists. The DHHS and NIH remained prominent, and a few stories began to cover other regulatory agencies, including the Environmental Protection Agency and U.S. Department of Agriculture, as regulatory responsibility was debated and eventually reformulated. With increased industrial development, the U.S. patenting office also emerged as a featured actor, as did the federal judiciary, with a number of court battles either over patenting and property rights or several legal challenges to biotechnology regulation. Similar to trends from the 1970s, other interests, including environmental, consumer, or religious groups, as well as bioethicists, were not prominent actors in coverage.

Coverage content, 1990 to 1999. The first half of the 1990s was relatively similar to the 1980s in coverage of themes, with a dominant emphasis on DNA research in general, pharmaceuticals and vaccines, human inheritance, and predictive medicine. Coverage of gene therapy, with the first human trials approved in 1991, increased during the early 1990s but did not comprise a significant proportion of coverage. Related to gene therapy trials and the growing popularity of in vitro fertilization, there was the reemergence of media attention to voluntary regulations. There was also a sharp increase in coverage of ethical issues. The early 1990s mark the first time consideration of ethics is given prominent attention by the media, with ethics being mentioned in nearly a third of all articles. Despite major product development related to agricultural biotechnology, genetically modified organism (GMO) release and plant breeding are not given prominent coverage.

With the cloning announcements and resulting political debate of 1997 and 1998, media coverage of the latter half of the 1990s was dominated by media attention to human and animal cloning. Also, with news of the first results of gene therapy trials that arrived mid-decade and the 1999 death of Jesse Gelsinger, there was a significant increase in media attention to gene therapy. With the events of 1999, media attention to GMO release also increased, though in comparison to other issues, it was not a prominent theme for the five-year period. Attention to plant breeding accounted for only a small proportion of coverage, as did agricultural biotechnology-related themes of food safety and biodiversity.

With cloning capturing much of the media's attention to biotechnology in 1997 and 1998, media coverage of DNA research in general, human inheritance, and predictive medicine decreased. A focus on ethical issues appeared in about a third of all articles in the latter 1990s. There was also heightened

attention to legal regulation, and for the first time in biotechnology's history there was significant coverage of public opinion.

In the early 1990s, the media's use of frames changed little from the previous decade, with an overwhelming focus on scientific progress and economic prospect. In the second half of the 1990s, however, cloning and later events related to agricultural biotechnology likely brought for the first time a substantial proportion of articles featuring an ethical frame, with this organizing device eclipsing the proportion of articles centered on economic prospect. This five-year period of coverage represents the greatest diversity of biotechnology frames across the thirty-year period of our analysis.

Reporting of conflict jumped dramatically during the last half of the 1990s, with close to 70 percent of articles featuring controversy. There was also much heavier mention of risks in media coverage. Although reporting on negative aspects of biotechnology appears to have increased during the events of the late 1990s, the media also included greater coverage of biotechnology's benefits.

Trends regarding featured actors during the first part of the 1990s followed closely those in the 1970s and 1980s, with university scientists and industry members continuing to dominate coverage. The events of the last half of the 1990s, however, brought a dramatic shift in featured actors, with, for the first time, an emphasis on media coverage of the public as a major actor in the biotechnology debate. Media coverage also featured a greater focus on the presidency and ethics committees and a slightly decreased prominence for university scientists and industry members. The personal celebrity gained by Roslin Institute scientist Ian Wilmut with the Dolly announcement increased considerably the measure of attention to scientists from private institutes. Religious interests also increased in prominence, though still only appearing as major actors in a few articles. Other interests, however, despite their increased efforts during the late 1990s, including environmental, consumer, and agricultural interests, remained on the periphery of biotechnology coverage.

Conclusions

Our content analysis identifies some important trends in media coverage of biotechnology over the first three decades of its research, development, and application. Before we elaborate on the implications of our findings, however, it is necessary to look more closely at some of the technical aspects of our study.

Some Data-Related Considerations

This study was limited to a content analysis of one national elite newspaper and one national elite newsmagazine. Although, as mentioned earlier, there are valid reasons for limiting this specific study to just those two publications, we are constrained to some degree in our ability to generalize to all American print outlets or to nonprint media sources. We are also constrained in our ability to reach final conclusions regarding the relationship between media coverage and competing interests involved in biotechnology-related policy development. Content analysis only allows for nonobtrusive observation of the final product of the media agenda-building and frame-building process, and even though several valid and reliable interpretations are possible from this type of analysis, there remains some degree of uncertainty regarding the actual inputs to the process or the specifics of the process itself. Other studies should complement our "visible source impact" approach with a tallying of source-media coverage success rates or with qualitative observations and interviews related to source-journalist interactions.

Our study also canvasses three decades of coverage related to multiple facets and issues within and related to biotechnology development. In adopting this approach, we gain a broad picture of overall trends related to biotechnology coverage, but we also lose some precision in measurement, as each facet of biotechnology, from plant biotechnology to human cloning, involves certain unique interests, themes, actors, and political interactions. In this direction, we recommend that future studies adopt our approach but applied to just one dimension of biotechnology, involving either content analysis or more qualitative case studies.

Finally, our study suggests that reliable measurement of latent media content remains a salient issue for the field of communication research. In the area of media coverage of biotechnology, we encourage future studies to pursue the further development of reliable measures of latent content that still maintain validity and meaning.

Outlook

Media attention to biotechnology. Our analysis of trends in media attention to biotechnology makes clear that biotechnology has steadily entered the public and policy sphere over the past three decades, with coverage gradually rising across each decade, following for the most part the growth in the biotechnology industry and the general level of technological and scientific development, as indicated by increases in overall research and development and market introduction of biotech products. Biotechnology coverage has

been heavily event-centered or episodic within years, peaking or plummeting across week or month in correspondence to the latest major article appearing in *Science* or *Nature*, the announcements of politicians or regulatory bodies, a major announcement at a scientific meeting, or the occasional high-profile incident such as the claims of scientist Richard Seed, the protests at the 1999 World Trade Organization meetings, or the death of gene therapy patient Jesse Gelsinger. Media coverage may ride high on the media agenda for a specific week or month surrounding major focusing events, but biotechnology across any one year still rests rather modestly on the media agenda compared to other major political issues or even other science and technology–related developments.

Character of coverage. In regard to tone, for the most part, our findings agree with previous studies: biotechnology coverage has been typified by an overwhelming absence of reporting on controversy, with coverage of benefits greater than coverage of potential risks. There are two exceptions to this generalization. In the late 1970s, there were elevated levels of reporting of controversy and risks linked to the rDNA debate (though risks still did not outnumber mention of benefits). This aspect of coverage was even more prominent in the latter half of the 1990s as controversy emerged surrounding cloning and, to a lesser extent, gene therapy and agricultural biotechnology.

It appears that during these periods of heightened political controversy, media negativity increases but not without also a proportional increase in positive coverage from the media. Here, two influences are likely at work. First, in times of political controversy surrounding biotechnology, interests on both sides of the debate increase their lobbying of the media, creating a greater number of competing claims to feature in coverage. Second, the objectivity norm of journalism is likely to create a polarizing effect, with every negative consideration featured in an article counterbalanced by a positive consideration related to biotechnology. In this regard, our quantitative findings agree with a previous qualitative assessment of the late 1990s coverage of cloning (Priest 2001).

Source influence. In assessing overall source influence, scientists, industry, and government actors have dominated coverage. This conclusion of a "mobilization of bias" and hegemonic influence of media coverage is supported by the results indicating the main actors that have been most frequently featured in coverage across time, as well as the consistent pro-biotechnology tone in coverage. It is also supported by the dominance of framing devices that accent elements of scientific progress and economic

development, as well as the heavy prominence of themes that highlight the development of pharmaceuticals and vaccines or emphasize patenting or property rights. Scientists and industry also appear influential in what issues are not covered by the media, including ethics, legal regulation, public opinion, and other competing interests, including environmentalists, religious groups, bioethicists, consumer groups, and the public in general.

Several instances of what appear to be "non-decision-making" episodes, where lack of media attention may have allowed a few interests to control policy, also support the likelihood of strong scientist, government, and industry source influence. In one example, during the late 1980s, when the federal government substantially reformulated biotechnology regulation in a fashion that promoted industry development, our media findings reflect little attention to themes of legal regulation and show little impact by nonindustry, nongovernment, or nonscientist sources. In an example involving the non-decision-making influence of government-related sources, the military is rarely if ever mentioned in connection to biotechnology across the thirty years of our analysis. Yet, second only to the NIH, the U.S. Department of Defense has been the major federal sponsor of biotechnology research and development (Krimsky 1991), suggesting that much of biotechnology research related to weapons or military applications has remained outside the media's agenda.

These "uncontroversies" and "nondecisions" are facilitated in part by a likely spiral of silence process, where one-sided media coverage cultivates the perception that consensus elite or general public opinion regarding biotechnology agrees with industry, scientists, and government positions. This perception, whether accurate or inaccurate, undermines the ability of dissenting interests to mobilize public opposition or even call attention to important policy decisions. This is not to suggest that all episodes or instances of nondecision making or "nonagenda setting" are the result of active attempts by privileged sources to exclude other interests or perspectives from coverage. Instead, as outlined in the literature review, work in media sociology (Gitlin 1980; Hallin 1987; Shoemaker and Reese 1996) demonstrates that nonagenda setting can be an unintended consequence of the shared culture between journalist and source. Specifically, certain minority perspectives that might fall outside society's dominant power structure are often inadvertently excluded or are never considered.

The pro-biotechnology tone of media coverage and the dominance of science, industry, or government sources are also attributable to journalistic preferences, as the media have relied heavily on these sources for technical information and routine channel news. The fact that the source-journalist

interaction has benefited pro-biotechnology sources at the expense of dissenting interests is promoted by a favorable run of history in the United States. Unlike other major industrial developments of the past half century—including chemical, petroleum, and nuclear energy technologies—there have been no major catastrophes related to biotechnology. An accident on the scale of Bhopal, Love Canal, Chernobyl, or Three Mile Island related to biotechnology would likely shift the rules of engagement between journalists and sources, lending greater legitimacy to certain interests that historically have been locked outside what Schattschneider (1960) characterizes as a restricted policy pressure system.

Within the American context, government agencies and scientists are widely considered credible and necessary authorities in matters of scientific and environmental uncertainty. In a world of increasing technological complexity that brings new and unknown risks, the public is heavily dependent on these experts and their institutions for reassurances and reliable information (Beck 1992; Giddens 1990). However, if events undermine the legitimacy of these sources, as was the case in the United Kingdom after the discovery and publicity surrounding mad cow disease or in Europe after inaccurate reassurances related to Chernobyl fallout, other social actors, including environmental, religious, and consumer interests, are likely to take on the role of experts in the media (Jasanoff 1997).

The events surrounding cloning in 1997 and 1998 and, to a lesser degree, the circumstances surrounding GM agriculture and gene therapy in 1999 offer some, but still limited, elements of biotechnology-related "crisis." For the most part, the scientific establishment, science journalists, bioethicists, and religious leaders were caught off guard by the Dolly announcement of 1997 (Kolata 1998; Silver 1998). More important, the sudden possibility of human cloning expanded the political arena surrounding biotechnology policy debate to include interests other than just scientists, industry, or government, legitimating the concerns of bioethicists, religious leaders, and the general public. With lesser impact, debate surrounding agricultural biotechnology and gene therapy likely served to also broaden the political arena. This reframing of biotechnology that suddenly helped mobilize and include a greater diversity of actors and perspectives in media coverage is supported by our findings that mark the latter half of the 1990s as the first period to include wider discussion of ethics, public accountability, and mention of the public, along with heightened reporting of controversy. Future and ongoing research should examine which features unique to press coverage in the last part of the 1990s have carried into biotechnology's new millennium.

Notes

1. The definition of *biotechnology* remains in some dispute, but following past characterizations of the technology by historians (Turney 1998), scientists (Silver 1998), science writers (Kolata 1998), and sociologists (Krimsky 1991), we decided in this study to include in vitro fertilization as part of biotechnology.

2. Kingdon (1984) defines the policy agenda as the list of subjects or problems to which government officials, as well as people outside of government closely associated with those officials, are paying some serious attention at any given time (Kingdon 1984; Linsky 1986).

3. In this analysis, we combine data first gathered and coded in 1998 with data gathered and coded in 2000. In the first study conducted in 1998, the full text of articles was obtained for the twenty-five-year period starting in 1970 and ending in 1994. In the second study, full-text articles were gathered for the five-year period from 1995 to 1999. In both instances, a population of articles from the two publications was constructed using a Lexis-Nexis database search of keywords related to biotechnology. All articles from the two publications that contained in the headline or the lead paragraph any of the keywords or parts of keywords "biotech*," "clone," "cloning," "genetic engineer*," "gene manipulat*," "gene technolog*," "gene therap*," or "recombinant DNA" were selected. For purposes of this study, we did not include the keyword "genome." The Human Genome Project, though related to the larger development of biotechnology, has a unique set of events and features that place it beyond the proper scope of this study.

The full text of articles available in Lexis-Nexis for the *New York Times* is only available back to 1981 and for *Newsweek* only available back to 1975. For both publications, library content indices, including the *Readers' Guide to Periodical Literature* and the *New York Times* paper index, were consulted for relevant articles not included in the Lexis-Nexis database, and photocopies of articles were retrieved from either microfiche or microfilm. For articles retrieved through Lexis-Nexis, once a population was determined, nonbiotechnology articles were excluded that contained similar words but were used in contexts unrelated to biotechnology (e.g., articles covering computer clones). The search for the years 1970 to 1994 resulted in a population of 948 articles. The search for the years 1995 to 1999 resulted in a final population of 356 articles across the two publications for the five years of our study. Due to the constraints on index availability for articles appearing during the 1970s, it is likely that our population slightly underestimates rather than overestimates the population of relevant biotechnology-related articles for both publications during this decade.

The full population of articles retrieved appearing between 1970 to 1995 was used in coding. For the 1995 to 1999 population, a 33.3 percent probability sample of the population of articles from the *New York Times* was selected and combined with the complete population of articles from *Newsweek*, resulting in a representative coding sample of 137 articles. Sampling procedures for 1995 to 1999 were used due to the inclusion of a greater number of publications in the originally defined population of news coverage, though as outlined earlier, for comparative purposes, only findings related to the *New York Times* and *Newsweek* are included in this article. Regardless, employing probability techniques in our sampling of *New York Times* coverage leaves us confident that our content data are representative of total *New York Times* coverage appearing across the five years.

4. Two sets of coders were used: one set of two coders (team A) for the 1970 to 1994 population of articles and a different set of two coders (team B) for the 1995 to 1999 sample. For coding team A, intercoder reliability across the variables used in this study was for themes ($r = .55$), frames ($r = .52$), risk ($r = .81$), benefit ($r = .78$), controversy ($r = .58$), and actor ($r = .43$). For cod-

ing team B, intercoder reliability across the variables used in this study was for themes ($r = .44$), frames ($r = .47$), risk ($r = .73$), benefit ($r = .71$), controversy ($r = .50$), and actor ($r = .48$). These lower than ideal reliability results are due to (1) a correlation comparison using dichotomous variables and (2) the strong tension that occurs in quantitative content analysis between highly reliable measurement of often less interesting manifest data versus the less reliable but often more valid measurement of more interesting latent variables. Moreover, the rating results reported here are equivalent to the results achieved by other researchers applying similar coding rules to media coverage across countries in Europe (Durant, Bauer, and Gaskell 1998).

5. In some cases, media attention may be almost totally journalist driven, with editorial decisions made to give attention to an issue without an apparent focusing event or source influence. These types of articles are difficult to identify without confirmation from journalists themselves, who even then may be reluctant to reveal their motivations for running a story.

6. In an example of the organizational restraints that might often influence media agenda building, James Fallows, editor of *U.S. News and World Report* at the time, decided to run a previously scheduled cover article on the nation's top graduate schools instead of coverage of cloning. Later, in regret, Fallows would comment that Dolly was the most important story of the past two or three decades (Kolata 1998).

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