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## Essay

# Wind Energy Landscapes: Society and Technology in the California Desert

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*There may be no more conspicuous example of a conflict between society and technology than a wind energy landscape. The fastest growing renewable energy resource in the world, wind energy has evoked a cool public response. Through the use of interviews, the published literature, governing legislation, and personal experience, this article examines this conflict near Palm Springs, California. Its purpose is to summarize and explain the opposition that developed there from the earliest days, what has been done to mitigate it, and how the local experience is reflected in similar developments elsewhere. This particular conflict between society and technology has the potential, with proper guidance, controls, and sensitivity, to diminish with time.*

**Keywords** California, desert, energy, landscape, land use, technology, wind

Despite its long, colorful use to propel ships, grind grain, and pump water, using wind resources to generate electricity is recent, starting in earnest in the mid 1980s. Today there is over 17,300 MW of generating capacity worldwide, and wind power is the fastest growing renewable energy resource anywhere. Germany leads the world, but Denmark, Spain, Italy, the United Kingdom, the United States, and many other countries are finding wind power a valuable, pollution-free, alternative source of electricity. When we try to understand what first gave modern wind energy its present momentum, we find that in large part it can be traced to the reactions and adjustments that started in San Gorgonio Pass (Figure 1). This essay summarizes the experience there as an example of what can happen when reputed public support for alternative energy collides with the reality of its existence.

The very harshness of the landscape of San Gorgonio Pass long protected it from development. It has always been a windy, dusty, noisy, and rather inhospitable place, and for centuries it was used only as a corridor for foot travel between the coast and

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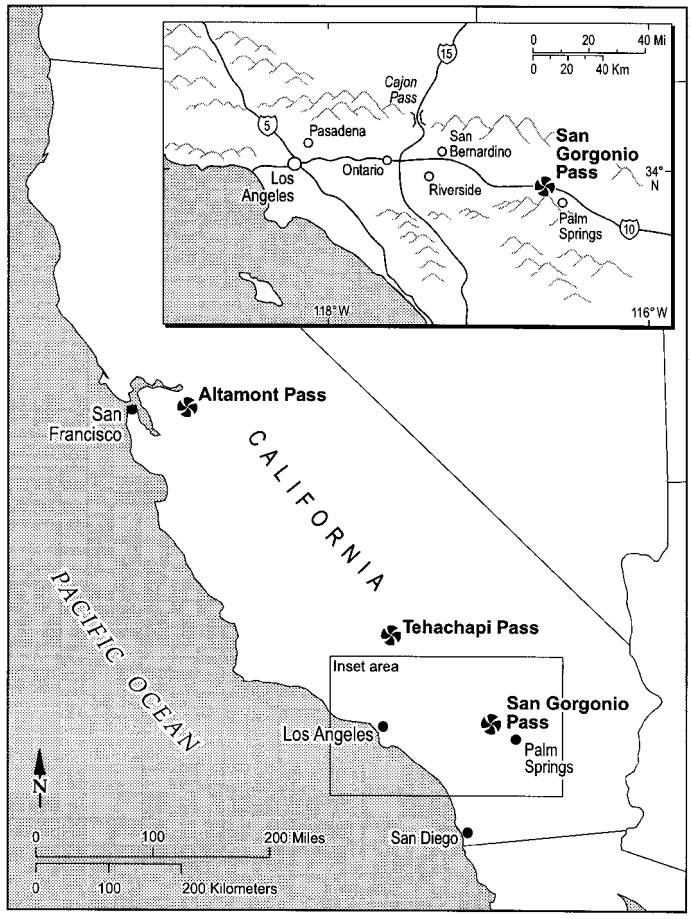


**FIGURE 1** Principal wind areas of California.

the desert. Today the wind jostles cars on the busy interstate highway that has been constructed there. It pits windshields, polishes rocks, cuts through telephone poles, and piles up sand. Rows of tamarisk and eucalyptus serve as windbreaks to shelter crops, houses, and golf courses. A persistent and important feature, the local wind remains part of life in this desert, and every traveler in the area had become accustomed to the barren nature of the landscape that it protected from change.[1] So it was that many were caught off guard when wind turbines started appearing. Citizens complained about their unsightliness, the noise they created, the threat they posed to wildlife, the risk of structural failures, and the interference they might represent for the safe use of aircraft. These criticisms triggered legal responses, political battles, regulatory sanctions, and a hardened undercurrent of public hostility toward wind power itself. Such reactions dismayed the wind power industry, which, consistent with public support of alternative energy, expected a more cordial welcome. They had thought that San Gorgonio Pass's winds and vacant land would be perfect for development, and in many ways they were correct. However, the site is also transited by thousands of people every day, many of them heading to the desert resorts, trying to escape the very "civilization" the wind landscapes represent.

Usually wind power is felt rather than seen. Today, wind turbines make it strikingly visible and the reaction of people to developments everywhere is mirroring those first

experienced in Palm Springs. In Great Britain, for example, projects were called a "new way to rape the countryside" (*The Economist* 1994). When people there argued that wind turbines were welcome alternatives to coal scars and the risks of nuclear power, the ensuing debate was called the "battle of the green giants" (*Western Mail* 1993). By the time wind turbines were being called "lavatory brushes in the air," the industry knew it had a fight on its hands.[2] The agile and clean power of the wind, it turned out, was carrying heavier baggage than anyone had anticipated.

## Landscapes of Power and Space

Meaningful wind development in San Gorgonio Pass started in the mid 1980s when metal support towers started rising off the desert floor. At social gatherings it was common to hear conversation laced with derisive comments about how wind turbines were "ruining the desert." Local newspapers carried public criticisms and political condemnations (Righter 1996). People complained that wind development had transformed a beautiful landscape of nature into a whirling landscape of power, and few were predisposed to accept such a dramatic change.

The resistance to wind power originates in its inherent spatial characteristics. As with hydropower and geothermal steam, development is necessarily site specific, unavoidably weaving itself into the fabric of local land use. To a smaller degree than either of these other resources, however, it is often most available in places where people tend to concentrate, such as along coastlines and near major passes used by highways. In San Gorgonio Pass the extra ingredient is the close proximity to the prosperous resort of Palm Springs (Figure 2).

By about the time when Hollywood was adding sound to film, Palm Springs was becoming a Mecca for Hollywood stars. Its attraction continues, but now the resorts are more accessible, and millions visit each year to enjoy the vistas, the luxury, the expensive restaurants, and the 90 golf courses. But despite the carpet of grass that incongruously covers the desert, the natural surroundings have changed little over

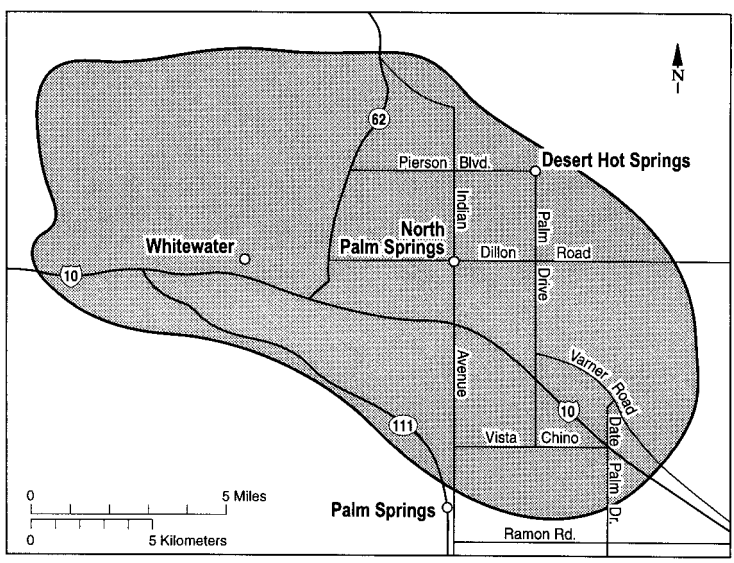


**FIGURE 2** San Gorgonio Pass wind area, depicting areas of more than 6 m/s, areas favorable to wind.

**FIGURE 3** Wind turbines near Palm Springs, with wind turbines obscuring the scenic desert mountain scenery. Photo by Martin J. Pasqualetti.

the years: The summer heat, the cloudless skies, the high mountains, the oases of palm trees, even the early form of Palm Springs are all much the same as they have always been. In short, one of the attractions of the area has always been its landscape permanence, and it was just this consistency that was disrupted by the wind farms. To the chagrin of local residents, retail businesses, and politicians, the prominence of the wind turbines made them Palm Springs's unofficial "greeters." They are impossible to miss (Figure 3).

Although the Palm Springs experience presaged the cool public support that wind power has received in other locations, wind developers have learned from mistakes made there. England, Denmark, and other European countries have been more sensitive to issues of landscape compatibility. Turbines in these places are more attractive, the colors more muted; the heights, types, and operation more uniform; and their deployment less cluttered and more integrated with the existing landscape (Figure 4).

## A Transformed Landscape

While the consistent wind of San Gorgonio Pass had long tempted developers, its transformation from transport corridor to industrial theme park was possible only after several ingredients came together: public support for renewable power, wind data, cheap and available land, technical capability, and a market price guaranteed by state and federal regulation. Wind turbines, once rooted, have grown quickly into one of the most distinct energy landscapes in the world. Being close to an area of exclusive and expensive resorts and private homes, it was not surprising that the complaints that quickly appeared came from successful, strong-willed, and politically astute people with the time, the knowledge, and the will to get their message to decision makers.

**FIGURE 4** Deployment of wind turbines along the coast at Kappel, Denmark, displaying conformity and uniformity. The 24 turbines, commissioned in August 1990, have a capacity of 9.6 MW. Photo by Jens Bygholm, used with permission.

Although they concentrated on the transformation of the landscape, they were even more offended when the turbines did not operate or when owners seemed motivated only by tax incentives.

Such accusations resonated with politicians and legal action soon followed, led by Palm Springs. The city sued the U.S. Department of the Interior, claiming that "its US Bureau of Reclamation and the developers had ignored mitigation procedures stipulated in the environmental impact statements, that many of the turbines were nonfunctioning and were an eyesore, that the inconsistency of sizes and shapes cluttered the landscape, and that the developments threatened the visitor's aesthetic experience and the city's tourism potential" (*Palm Springs vs. US DOI 1985*). Riverside County, responding both to the notoriety that followed this suit and to the many grievances that had been logged by citizens and visitors, held hearings, financed a public opinion survey, and created a wind planning document for all future developments to follow (Palm Springs 1994). The attention, the nature of the objections, and the responses of the local planning authorities would influence wind research and development elsewhere (Personal interviews: Nick Goodall, chief executive, British Wind Association, London, 1998; Martin Hoppe-Kilpper, chief, Wind Energy Department, Institute for Solar Energy Supply Technology, Kassel, Germany, 1998; Frode Birk Nielsen, principal, Birk Nielsens Tegnestue, Denmark, 1998).

## The Regulatory Response

The wind industry adjusted to public resistance with a series of initiatives, starting with a program of education about wind power, pointing out that wind power produces no

toxic waste, no radiation, no acid rain, no greenhouse gases, no thermal discharges, and no irreversible landscape changes. Though correct on all counts, there was still nothing the industry could do or say that would make the turbines invisible, and this left the most glaring infraction of wind power unresolved.

In response, buffers were put in place in the form of legal controls, protections, and conditions. Today, the Palm Springs planning ordinance permits wind turbines in zones W, O-5, E-1, and M-2: that is, watercourse zones, open land zones, energy industrial zones, and manufacturing zones. The ordinance specifies safety and scenic separations ("setbacks"), underground collector cables, neutral "environmental" paint color, a 200-ft height limit, advance drawings or other images showing the appearance of proposed windmills, and a bond for decommissioning in the event of inoperable or dangerous equipment. Outside city limits, Riverside County imposes similar requirements. Subsequent additions to these ordinances included legal protections for rare, endangered, and "charismatic" birds such as eagles and hawks, and these requirements included mandatory reporting of any bird killed by a wind turbine.

The relative quiet of deserts is one of the attractions of visiting there, and some of the greatest detail in the local ordinances was reserved for noise control. County regulations, for example, stipulated that noise levels of the wind energy conversion system (WECS) must be 45 dB(A) or less, unless the noise is considered a "pure tone." All land parcels in the vicinity of the commercial WECS project property used or designated for residential, hospital, school, library, or nursing home purposes must be identified. A commercial WECS or WECS array must be operated at a noise level not to exceed 65 dB(A) with no impulsive sound below 20 Hz adversely affecting the habitability or use of any dwelling unit, hospital, school, library, or nursing home. All noise measurements and noise projections must be made in accordance with the technical specifications and criteria developed by the County Health Department and adopted by resolution of the County Board of Supervisors. A toll-free telephone number, established for each commercial WECS project, was distributed to surrounding property owners to facilitate the reporting of noise irregularities and equipment malfunctions.

The noises produced by turbines range from constant high-pitch frequencies to low periodic pulses. The degree to which these noises disturb people varies with individual sensitivity, as well as with distance, insulation, ambient noise levels, blade and turbine design, and other factors. Noise ordinances have prompted several improvements, including a refined blade aerodynamic, replacement of lattice towers with monopoles, using turbines with three blades instead of two, and installing quieter upwind designs.

Although complaints about noise from the turbines have declined (personal interviews: Richard E. Patenaude, planning manager, Department of Planning and Building, City of Palm Springs, 1998; Paul F. Clark, senior planner, Riverside County Planning Department, Indio, CA, 1998), the problem is still part of the public perception about wind power. In the United Kingdom, for example, opponents of wind development have targeted noise with considerable intensity. Modern wind turbines are so quiet, however, that the experience there has been more anticipated than realized.

## The Evolving Public Perception of Wind Landscapes

Public complaints about the wind landscapes led Riverside County officials to commission a public opinion survey to help in developing legal controls. This assessment reflected the perceptions at the time and established a benchmark in the development of public opinion about wind power. Its basic conclusion was that despite the vocal public objection to the wind energy landscape, a majority of people polled responded

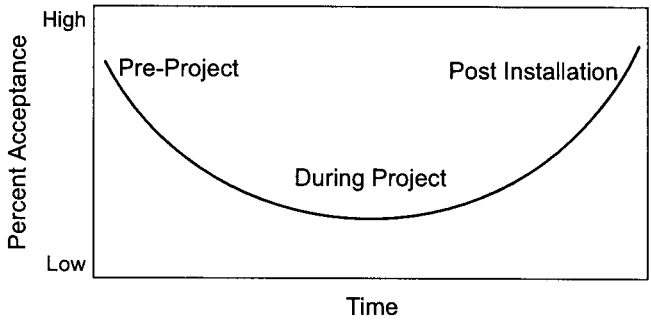


**FIGURE 5** Progression of approval. Source: Arkesteijn 1992.

favorably to the developments and considered the development of wind energy a "good thing." Two-thirds of the majority also believed that further development of wind power should be encouraged. Only 35% agreed that the wind developments diminished the value of land located close to the machines (Pasqualetti and Butler 1987).

The results of the survey contrasted sharply with the negative impression one gathered from reading the local press (Righter 1996). Moreover, surveys in other areas of wind development yielded comparable results. For example, in the gentler topography and greener environment of Altamont Pass, 50 miles east of San Francisco, the public was found to favor wind power (Thayer and Freeman 1987; Thayer and Hansen 1991). In England, the Energy Technology Support Unit (ETSU) found that for 80% of respondents the level of concern over wind development fell to 29% once wind turbines were actually in place (ETSU 1993). Underscoring the ETSU findings, the existence of wind farms in southwest England "altered attitudes in the direction of local residents being more favourable toward wind energy," with many of the worries that local residents had about wind turbines having been proved unfounded (Elliott 1997). These reports suggest that public reactions to wind power tend to progress toward approval, rather than opposition (Figure 5).

## The Cultural Landscape of Wind

There have been many improvements in technology, operation, and regulation since wind power's rocky start in San Gorgonio Pass. City and country officials report that public objections to wind power are now "virtually nonexistent" (personal interviews already cited with Patenaude, 1998 and Clark, 1998). Although public silence is not a firm reflection of public acceptance or a softening of public concern, news media and politicians rarely focus on wind power anymore. As if signaling a growing public acceptance, several new homes have been built squarely among the wind turbines (Figure 6).

Several additional signs point to a public adjusting to wind energy landscapes. One of them is "wind tourism," an activity with rare precedents in the energy industry. So curious and intrigued are many travelers that people commonly stop to photograph the wind's new and evocative landscape of power. In an ironic twist, not a few members of the same film industry that once sought recreation and relaxation in the turbine-free desert of old have been incorporating the new wind landscapes as a backdrop for advertisements and movies, precisely because they are so evocative.[3]

In the United States and elsewhere, wind energy promoters have been actively issuing press releases, making presentations, hosting visitors, and organizing conferences. The Tehachapi Chamber of Commerce helps organize an annual Wind Energy

**FIGURE 6** Houses among wind turbines in north Palm Springs, an unincorporated area directly in the wind belt of San Gorgonio Pass. Photo by M. J. Pasqualetti.

Fair to promote the contributions of wind energy to the community. In Altamont Pass, developers publish brochures and provide tours. And in England, wind tourism at Delabole (Cornwall) attracted 100,000 visitors in its first year of operation, providing free and open access, complete with paths to facilitate tourist walks around the wind generators. Such reactions, plus the responses to several surveys, suggest that the public reaction to wind power is more positive than negative.

The continuing expansion of wind landscapes supports future optimism. With wind projects appearing recently in Texas, Pennsylvania, Minnesota, Iowa, Vermont, New York, and California, along with thousands of megawatts of new capacity in Europe, investors are obviously sensing wind power's potential for profit (Chiles 2000). Where there is potential tax revenue, politicians are not far behind, as suggested in Palm Springs. When the mayor, former entertainer Sonny Bono, learned that wind generators could generate taxes as well as electricity, he reversed his earlier opposition to the fields of turbines sprouting nearby and led the effort to sweep an additional 20 square miles of adjacent desert lands into the city's tax base (personal interviews already cited with Patenaude, 1998, and Clark, 1998). This action marked the end to meaningful political opposition and underpinned the wind industry's plans for expansion.

Support for wind power, already rising in some places, is likely to widen as some of its monetary benefits become more apparent. In some locations, for example, landowners are relying on wind developments to enhance rather than reduce the value of their property, because wind generators allow multiple incomes of the same land parcels. This advantage is possible because wind turbines, unlike other forms of generation, require no elaborate, expensive, or hazardous infrastructures for continuous fuel supply, no power plants, no emission control or waste disposal. Most of all, the pads

of the turbines physically take up very little land, perhaps as little as 5% within a given distribution of turbines.

While wind power support towers can make harvesting more difficult in farming territory such as Buffalo Ridge, IA (Chiles 2000), it is of little hindrance in cattle country and can actually benefit ranchers. In Altamont Pass, for example, where grazing has long been common, wind power helped maintain the local way of life by providing extra income and keeping ranch lands out of reach of housing developers.

One of the most unique attributes of wind landscapes is their impermanence. In contrast, the greatest environmental burden of hydroelectric dams, mines, and waste sites is the momentum of landscape change they accumulate. Recognizing impermanence as an attribute of wind power, the Palm Springs wind ordinances direct that "any unsafe, inoperable, or abandoned WECS or WECS for which the permit has expired shall be removed by the owner or brought into compliance" (Palm Springs n.d.). The ordinance further stipulates that once a site is cleared it will be restored to its preinstallation condition. Bonds required to cover the cost of removal and site restoration have already been used in San Gorgonio Pass to remove disused and inefficient equipment.

Although such legal requirements are not a uniform component of U.S. wind developments, the reclamation provisions found in San Gorgonio Pass have been repeated elsewhere, including Europe. In the United Kingdom, for example, "When a wind farm reaches the end of its design life, the turbines can be easily removed and the foundations could be reused for the installation of new turbines subject to planning permission or, if required, the land could be reinstated" (UK Department of Energy 1992). Despite the substantial visual impact that wind energy tends to produce, the steps of dismantlement, removal, and site restoration are simple, requiring none of the technical sophistication that is necessary to remove radioactive nuclear components, massive concrete dams, or even complicated coal-fired generating stations. A lasting landscape legacy is absent with wind power, and this is one of its clearest advantages.

## Knotted to the Land

In contrast to our relatively recent interaction with fossil fuels, uranium, and hydropower, we evolved with the wind. Thousands of years before anyone sold a lump of coal or pumped a drop of oil, wind was in use grinding grain, lifting water, and propelling boats to new ports of call. The wind has become so much a part of us that we often feel out of sorts when the air is still. But despite our long and varied familiarity with the wind, using it to produce electricity seems to have taken us by surprise. When the quaint historic wind machines of our memories gave way to the giant wind generators of today, many considered the landscapes they produced odious, even sterilized of natural beauty. They were taken aback when, after abstractly supporting alternative energy resources for years, they were facing the landscape realities such support produced. Petulantly, they were insulted by the presumption that they would find wind energy landscapes acceptable solely because they were a renewable energy resource. Undoubtedly, more work will be necessary before wind power can reach its greater potential.

## Future Directions of Research and Policy

The new era of wind power has evolved quickly, and while at first it stimulated a noisy and largely negative public response, it is difficult to find fault with the speed of progress that has been made to mold it into an acceptable renewable resource. Only

20 years into the modern development of wind power, many of the sources of worry and disapproval have already been addressed successfully. Within that short period, the challenges of turbine size, color, finish, spacing, noise, efficiency, reliability, safety, and decommissioning all have been remedied or conceptually solved by developers, equipment manufacturers, and regulatory authorities. That such progress was possible in such short order evinces wind power's inherent environmental compatibility, a trend that is especially noticeable when compared with the opposite trend experienced during the increased reliance on traditional energy resources.

With wind power, what you see is quite literally what you get. This has been suggested as its greatest test, but it is clearly also its greatest asset; problems are easy to spot, are short-term and reversible, and are easier to address. With wind power there are no worries about global warming, oil spills, mine reclamation, radioactive waste, or strategic vulnerabilities. Such inherent advantages, in concert with wind's potential generating capacity in many locations, suggests the good sense of trying to resolve remaining public concerns.

These concerns mostly revolve around the two topics of aesthetics and threats to birds. Already progress has been made on both these themes, both here and abroad. In Palm Springs, as we have seen, enacted regulations have addressed visual considerations of design, diameter, color and paint schemes, numbers and spacing, height, noise, and endangered species, as well as adornment and advertising. Equally important to the developments are preexisting local conditions such as vegetation and topography, particularly when developments are in broad valleys such as near Palm Springs, on ridge tops such as near Tehachapi, on flat farm land in the upper Midwest, among small farm parcels and dense rural populations such as Wisconsin, or on flat lowlands such as the Netherlands and parts of Denmark.

A second area of needed policy development is in the identification of areas suitable for wind development in North America, a task that involves much more work and thought than simply installing and monitoring anemometers. Not everywhere the wind blows is environmentally ideal for wind turbines; even the best possible turbine engineering and design can be unsuitable for some locations. Wind resource areas should be categorized in terms of erosion potential, visibility, proximity to habitations, and threats to wildlife. This should be integrated with any preliminary technical consideration.

A third area of policy development is social impact. This theme is tied with some of the matters of visibility and housing mentioned earlier, but another aspect is the need for appropriate proactive educational and planning intervention, especially with citizens who live, farm, ranch, or recreate in the area. We need further understanding of who benefits and how the benefits affect public response, whether ownership makes a difference, how noise intrudes into rural life, and how large-scale wind development (50 + turbines) and small-scale wind (5–50 turbines) differ in their effect on the local social fabric.

These are some of the specific steps that need to be taken to help make wind power a significant and environmentally acceptable contributor to our energy mix, but they all fall within the overall consideration of how society reacts to the resurrection of this age-old energy resource, and by whether its development makes any sense in today's world. The answer to these questions is, to a greater degree than for any other source of energy, knotted with the land, and especially to California. When future historians examine the place of early, 21st-century wind power, they will find the landscapes that wind power produced, the responses that such landscapes provoked, and the eventual contributions that wind power made. They will trace these back to the desert oasis of

Palm Springs and the San Gorgonio Pass nearby where wind landscapes, once greeted with hostility, evolved toward a less resentful sort of accommodation and acceptance.

## Notes

1. According to Battelle's Pacific Northwest Laboratory's *Wind Energy Resources Atlas* (1986), the San Gorgonio Pass resource is 6.3 m/s (14 mph), yielding 365 W/m$^2$. It is a Class 6 area (of 7 classes) at a 10 m altitude above the ground.

2. Attributed to Sir Bernard Ingham in describing the wind farm near Hebden Bridge in Yorkshire, England. Cited in David Elliott (1997, 107).

3. For example, the film "Rain Man."

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