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The Typology of the Game that American, British, and Danish Crop and Plant Scientists Play

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Abstract Drawing from contemporary social science studies on the shifting regime of research governance, this paper extends the literature by utilizing a metaphoric image—research is a game—observed in a field engagement with 82 American, British, and Danish crop and plant scientists. It theorizes respondents' thinking and practices by placing the rules of the research "game" in dynamic and interactive tension between the scientific, social, and political-economic contingencies that generate opportunities or setbacks. Scientists who play the game exploit opportunities and surmount setbacks by adopting strategies and reinventing tactics in order to maximize their winnings and to minimize their losses. Winners become superstars who decree what is open, closed, or doable science for the majority of the scientific community.

Keywords Typology of the game of research · Game metaphor · Metaphorical theorization · Public university researchers · Online and popular games

Introduction

Since the 1960s, Europe and North America's science policy makers have sought to harness science for social and commercial ends. In addition, networks of other knowledge actors in finance, politics, industry, business, and civic groups have joined the realm of research governance (Pestre and Weingart 2009). Certainly, scientific endeavours oriented towards military, social, or commercial aims can be traced back to the institutionalization of science in public colleges in the eighteenth

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century (Pestre 2003; Godin 1998). However, it was not until the post-war period that governments across Europe and North America adopted policy instruments for directing scientific priorities. Public scientific research was mandated to contribute to the competitive global knowledge-economy (Bruno 2009), even when it was part of the "science-base." This is not new (Godin 1998; Gieryn 1983; Kline 1995). What may be new, however, is government use of strongly steered models of research governance. Heavily dependent on government or corporate funds, researchers have had to respond creatively to these directives and their shifting influences on science.

Unexamined thus far, the metaphors that public university researchers (hereafter researchers or scientists) use to describe creative ways in which they resist or accommodate new rules of research governance can be an extremely powerful tool for understanding the reality of research life today. The mode-2 (Nowotny et al. 2001) and triple-helix (Etzkowitz and Leydesdorff 2000) theories are probably the most influential macro concepts. Distinct from mode-1, the classical ideas of research as described by Polanyi (2000) or Merton (1973), mode-2 provides dichotomous thinking in what is described as a "new co-production" of socially robust knowledge. Mode-2 also provides a conceptual scheme for acknowledging the shaping of science by society through outlined demands and expectations, as opposed to the ideas of Polanyi and Merton, which isolate science from social steering. However, as a theoretical scheme, mode-2 is limited because it is too general in its method (Shinn 2002). Since the co-production of science and society is as old as science, mode-2 fails to define precisely what is new in contrast to past research practices (Godin 1998; Pestre 2003; DeJager 1993; Palladino 1990). Also, mode-2 fails to outline the mechanisms through which specific demands and expectations on researchers help to push the frontiers of science, develop abilities of scientists, and defend the integrity of science (Barnes 2007).

The triple-helix theory engages with government-industrial-academic collaborations. It provides a lens for seeing how commercially tied research opens up new opportunities researchers may have previously been socialized to resist such as new forms of rewards, recognition, and financial incentives. However, as a conceptual frame, triple-helix is limiting due to its broad generality, excessively complex language, and the resulting failure to fulfil its methodological promises (Godin 1998; Shinn 2002). Also, it fails to provide tools for understanding how material motivations can, in themselves, enhance scientific endeavours and success in contrast to intrinsic non-material motivations promoted by mode-1. Indeed, it overlooks the limits of material motivations or their possible negative effects on science (Barnes 2007).

However, by paying attention to metaphors that researchers use to convey their thinking and practice, we can bring current research realities to bear on critical reflection. Also, a theorization of researchers' thinking and practice can point at emergent meanings of present day research in ways that are inconceivable through mode-2 or triple-helix accounts. Although this study draws from these accounts, it seeks to extend them by engaging with a metaphoric image—"research is a game"—which was observed in our field engagement with American, British, and Danish crop and plant scientists.

An examination of scientists' thinking and practice is in line with a growing number of micro science studies (Vallas and Kleinman 2008) that pay attention to researchers' descriptions of their research realities and practices under the shifting regimes of research governance. These studies advance nuanced and subtle insights missed by mode-2, triple-helix, Mertonian and Polanyian macro-conceptual schemes. Grounding her study on principle-agent theory, Morris (2000, 2003) examined British medical life scientists' accounts of their research lives. She suggested that little has changed in terms of how researchers see themselves and their practices: what has clearly changed is how researchers *talk* about their work and activities, e.g., how they "put in a climatic coat." She noted that researchers are pragmatic about the political-economic reality of the research context. Accordingly, researchers "play up" to funders' demands or expectations while continuing with what they do best—as defined by Merton or Polanyi. This observation provides a way of seeing current day research that is unavailable through the dichotomous thinking provided by macro frameworks. However, Morris did not engage with metaphorical thinking or *talk*, which she saw as the icing rather than the cake. Furthermore, Calvert, using boundary work theory (2004, 2006), examined current day British and American physical and medical life scientists' understandings of the idea of basic research. She observed researchers strongly defending the idea of basic research, scientific freedom and autonomy. Researchers described the idea of basic research as flexible and contingent, and indicated that they "tailor" it to fit the given context. Calvert's "tailoring" notion allows us to appreciate the fluid, contextual and contingent nature of basic research. However, like Morris, Calvert did not engage with metaphorical *talk*.

Also, in a recent work engaging with twentieth and early twenty-first century American public university electrical engineers, biomedical scientists and industrial research managers' accounts of their research, Shapin (2008) described how free and autonomous scientific endeavours have been enhanced by practices of inspiring industrial research managers. He also noted how free-and-autonomous, private-gain, and public-good scientific endeavours have been enhanced by practices of inspiring public university research figures. Shapin observed how "charismatic research leaders" are critically important at a time of "normative uncertainty," and how the spirit of charismatic leaders energizes and generates lab or research groups' commitments. Shapin's notions of the "normative-uncertainty, embodied intuition and embodied leadership" of a charismatic research leader are interesting in the way they capture how visions and practices generally associated with public university science can and do thrive in industry, and how, under charismatic leadership, those generally associated with industrial science can thrive in public universities. Observing that research governance faces chaotic conditions and normative uncertainty, Shapin contended that a solution lies in the abilities of charismatic research leaders and proposed an experiment with charismatic authority (2008, p. 267). This interesting conception provides a rationale that liberates us from a dichotomous way of thinking that informs established social science accounts about the shifting regimes of public research governance. Moreover, Shapin noted among his respondents the use of a game metaphor to describe their research experiences with phrases such as "how the game is played" (2008, p. 241) and "the only game

in town" (2008, p. 262). Yet, like Calvert and Morris, he did not engage with this metaphorical thinking or *talk*. These scholars' failure to engage with scientists' metaphorical thinking or *talk* could be the result of their research design. It could be because metaphors are known to be part of our everyday language, communication, and interaction, and so we hardly recognize them as important or productive tools for meaning production. Also, it could be because metaphors paint simple, colorful, obvious, and commonsensical pictures that easily elude our attention by appearing playful, deceptive, or uninformative (Lakoff and Johnson 1980; Maasen and Weingart 2000, pp. 24–25).

However, the spontaneous and independent way in which the game metaphor was offered and kept re-emerging in our engagement with American, British, and Danish crop and plant scientists compelled us to recognize this metaphor as a window for accessing current research reality and reflect on it critically. It especially promises to spell-out inferences involved in our respondents' metaphoric thinking and acting, which they may ignore or play down. Moreover, engaging with the changing regimes of research governance, a metaphoric theorization of our respondents' practices can point at emergent meanings of present day research practices in ways that are inconceivable through established social science models.

Our metaphoric approach is in line with a growing number of science studies that recognize metaphors as powerful tools for explaining, sustaining or generating social realities. This scholarly work examines metaphors that scientists use to make their empirical scientific data meaningful and effective in science communication, as opposed to metaphorical modelling of research life under the shifting regimes of research governance. For example, Maasen and Weingart examined the role of "chaos, struggle or Kuhn's structure" metaphors in the dynamics of scientific theorization in the natural and social sciences (2000) and the social influences in this theorization (Maasen and Weingart 1995). Also, Knudsen (2005), Keller (1995) and Colyvas (2007) examined metaphor use in the dynamics of theorization in molecular biology (Maasen and Weingart 1995, p. 16; Knudsen 2005; Keller 1995). These science 'metaphor' scholars made convincing cases for how scientists use metaphors to convey the essence of their scientific findings, innovations or developments. Also, they explicated the innovative, generative or explanatory power of metaphors in the world of research. This insight is illuminating and inspires our metaphorical theorization of the changing regime of research governance.

Theoretical Background

We understand metaphor as the transfer of an image whose main aspects are well understood in one context to another context, in which it unfolds its transferred meaning in interaction with that foreign context (Maasen and Weingart 2000, p. 20; Maasen and Weingart 1995, pp. 16–17). We assume that it is now accepted that lay or everyday words or ideas are transferred to science and vice versa in human interaction and communication (Knudsen 2005). We assume that metaphor can be a tool that explains and facilitates the understanding of an existing worldview; a tool

for constituting a completely novel social reality; or a tool for sustaining collectively endorsed belief, meaning, and so on (Lakoff and Johnson 1980).

Our respondents' invocation of the game metaphor is not at all novel. In the philosophy and sociology of knowledge, it is sanctioned by Wittgenstein and Bloor (1997) to capture how social reality is created by coordinated and collectively endorsed human thoughts, talk, and practices in a given community or society. In this view then, a game is a self-creating, self-referring, and self-sustaining system. Gozzi (1999) observes how business executives invoke the game metaphor to highlight deceptive or dishonest behaviors or actions. Malaby (2007) has observed how game thinking or games such as gambling, poker or backgammon serve as models for real-life judgments and actions. Organizational studies have observed how game images model employees' work and life experiences (Hogler et al. 2008, p. 396; Koch and Deetz 1981, p. 5)—with stakes, roles, goals, uncertainties, players, winners, losers, stars, fun, setbacks, tactics, and strategies. Career counselling scholars (Pryor and Bright 2009) propose the game metaphor as a model for career judgments and actions, and as a model for helping clients face the contingent and uncertain nature of career life. A game approach avoids views of career life as goal-directed, certain, controllable and predictable, and instead sees it as complex, interconnected, changeable, unpredictable and prone to luck and serendipity. Indeed, in sports games, weather, venue, sponsors, and audience support change and shift. Players face last-minute accidents or breakdowns. Also, players lack the ability to predict or control other competing players' talents, performance abilities, skills, training regimes, resources, and strategies. Uncertainties or setbacks shape the outcome of the game. However, tough or talented players see uncertainties and setbacks as challenges to surmount. They exert greater effort, practice harder, develop their abilities, hone new skills and tactics—all in order to maximize winnings and minimize losses (ibid).

The Study

The present study forms part of a broader inquiry into how American, British, and Danish scientists cope with and respond to their respective national research reforms. We studied crop and plant scientists in diverse sub-disciplines such as molecular biology, plant physiology, ecology, genetics, systems biology, functional genomics, bio-informatics. Our research method involved in-depth semi-structured interviews with public university or research institute scientists across America, Britain, and Denmark between 2005 and 2008. We made 40 American, 28 British, and 20 Danish interviews. Interviews were tailored to each scientist, allowing flexibility for interviewees to shape the 1.5 h discussions. We informed all our interviewees that they would remain anonymous. We accessed our interviewees through a combination of random selection and snow-ball methods. All were very keen that we gather as balanced a picture as possible. Indeed, scientists directed us to colleagues who held different views themselves.

Genomic crop and plant researchers were selected because genomic crop and plant science is one of the scientific fields that developed and thrived under the

changing regimes of research governance. The study of American, British, and Danish scientists was carried out because during our first field interviews, British scientists expressed an interest in a comparative analysis of Britain, the U.S., and another European country. In addition, Danish research policy makers are interested in the British and American experience. A study of the differences and similarities between the three countries may generate empirical studies that could further public and science policy debates.

Research is a Game

Our respondents used the game metaphor, nested metaphors, or comparable statements to explain their research experiences and practices. A senior British scientist offered the following comments spontaneously and independently:

> It's a bit of a game, I've always thought of it as a bit of game, it's about kind of getting funding, doing what you want and kind of juggling you know what you'd really like to do with what you said you'd do. So it's a bit of a game…Funding is all run by scientists who kind of like me sort of understand the game.

In the light of classical, mode-2, and triple-helix theories, the game metaphor first appeared as lacking insight. However, its significance as a model for scientists' thinking and practices became compelling when it kept re-emerging spontaneously in our subsequent interviews. An influential British scientist stated:

> That is the only game in town…There are two games you can play…These are not games played by people who are inaccessible and there for life; they are games played by people, by and large, who put in a hell of a lot of time for damn all in the way of reward or in order to try and help the [scientific] system.

Also, a leading Danish scientist consistently described scientists' practices as "part of the game." When questioned further, this respondent explained:

> It *is* a game, to be a researcher, that's a game. There are so many rules that you play by. The rules that you have to play by to get funding, the rules that you have to play by to get students, the rules that you have to play by to get visible, so it is a game. It is a game also where you have to be multi-talented in some way to be a researcher today, to be able to successfully play by the rules. It is also a game the way you sometimes have the feeling that the success, to have success is not only a matter of being good and having the sufficient expertise; it is also a matter of luck and having the right connections or whatever it is. So it is kind of a game.

Similarly, one influential U.S. scientist stated:

> A lot of the really great scientists here do not get involved, they may get involved in responding to requests to participate in this or that, but actually the

> real game, the transformative game, is initiating things. It is not sitting on panels. It is creating new ideas that become panels and committees and things like that.

It is worth noting here that not all respondents precisely used the game metaphor. Still, comparable nested terms or statements invoking the directionality of research as a game were voiced across the case countries, as exemplified by this comment offered by a senior Danish scientist:

> Some people will actually almost have published the results before they make the [grant] application, and then they use that application to generate results that they can use for the next application. This is a commonly known principle.

Similarly, in the U.S., in addition to offering how colleagues were "playing the game," a respondent volunteered:

> I still consider myself a developmental biologist, physiologist…In the U.S. now, to get funding mostly you have to have a strong complement to molecular biology research…My level, if I were given a choice, my level where I feel it is more satisfying is the level of physiology rather than molecular biology. I also realize that if you do only physiology, you are not going to get funding.

Typology of the Game

What do we "see" then, when we start to view as a game the practices and thinking offered by our respondents? To start, the act of discovering a novel scientific idea—and publishing it as a high impact paper in a high impact journal—can now be seen as sharing some similarities to the act of striking a decisive goal in a football tournament, or breaking a record in an Olympic race, for example. We can imagine that although the game involves high stakes, it is great fun. We can start to see leading or influential scientists as we see great sports stars—and to imagine them as possessing special abilities, skills, talents and mental toughness. We can see these stars as earning rewards akin to those earned by great sports stars: money, prestige, power and social status. Also, we can now imagine researchers' networks of relationships with politicians, funding officials, industrial scientists or CEOs or journalists as acts of cooperating with dealers, sponsors, middlepersons, or as instances of player-coach relationships.

However, and as illustrated in Table 1, although the game of research is marked by accepted regularities, patterns of rules, practices and meanings (Malaby 2007; Steinkuehler 2006), the game is semi-bounded and influenced by scientific, social, economic and political contingencies. Accordingly, it cannot be reduced to its rules, design or conventions as Mertonian, mode-2 or triple-helix accounts would have it. Contingencies generate both predictable and unpredictable outcomes (ibid). For example, our respondents revealed how they utilize tactics such as disguise and deception. Such tactics were viewed as part of the research game today, and were

Table 1 A typology of the game that American, British, and Danish crop and plant scientists play

Game play	Tactics	Abilities	Outcome
1. Publish	High-impact papers, especially in *Nature, Science, Plant Cell*	Serendipity, seeing skew angles, sensing lucky situations—and importantly, being the first in the world to see and publish a valuable discovery; time and space; funds; rhetoric	High status, high-value, prestige, lucrative deals, trophies, relations of power and resources
2. Cooperate	With top-notch students; Reputable or influential scientists; Research agency officials or professionals; politicians; journalists; industrial scientists; corporate CEO; NGOs; foundations, etc.	Social intelligence, communication, fund-raising, resilience, hard work, flexibility	Money and resources
3. Enrol shepherd dogs	E.g., powerful politicians, industrial groups, star scientists, etc.	Social intelligence, communication, fund-raising, resilience, hard work, flexibility, plus rhetoric	Money and resources
4. Disguise	As GMO; bio-energy; global climate change; sustainable agriculture; global food security; bio-economy; systems biology research; etc.	Social intelligence, communication, fund-raising, resilience, hard work, flexibility, plus rhetoric	Money and resources
5. Be or follow superstars	"Shakers and movers" (U.S.); "guru," Prima Donna (Britain); "pink pink" (DK); influential or eminent scientist (All)	Same as 1 and 2, plus a big ego, visionary, aggressive, charisma	Same as 1 and 2
6. Lobby	Via professional community or lobby organizations	Same as in 2 and 3	Same as 2
7. Double helix	Engage in imperfect/rival teams	See 5 above	Same as 2
8. Deceive	Done 50–100% of a research idea? Base a bid on it!	Fund-raising	Same as 2

defended as ethically acceptable in response to political-economic realities. Although such emergent practices are in stark contrast to established accounts of research rules, they generate new meanings and practices in the game of research. Space does not allow us to engage with all the research practices we observed in the field. Since some of these practices are as old as science and extensively analyzed elsewhere (Merton 1968; Shapin 2008), in this paper we will elaborate on four

practices (cooperation, lobbying, disguise and double-helixing), which promise to bring interesting insights.

Utilizing Cooperation Strategies

Researchers indicated that teaming-up with scientific or non-scientific players, dealers, or investors they considered as resources was part of the game. 70% of our respondents stated that these resources were very important for a successful research life: typical comments were "having the right connections" or "networking is extremely important." They referred to "our contacts at BBSRC" or "our partners at NSF," or stated, "there are hundreds or thousands of those people in the agencies and I was lucky I identified a couple that made intellectual connections to them and they became susceptible to our ideas." The networking practices offered by our interviewees share characteristics with practices common in cooperative games. We understand cooperative games as involving two or more individuals whose interests are, first:

> Neither completely opposed nor completely coincident…Opportunities exist for players to be able to work together to achieve a win–win condition. A cooperative game does not always guarantee that cooperating players will benefit equally or even benefit at all (Zagal et al. 2006, p. 25).

Second, as distinct from collaborative "games that really work" (for example, Lords of the Ring), all players have only one goal; they share similar interests and beliefs, outcomes, rewards or penalties; and they endeavour to be better teammates (Zagal et al. 2006, p. 26).

Our respondents teamed up with company CEOs, former colleagues, or students now in relevant industries. A key element in these connections is that the players are known, respected and trusted mates. The former are both teammates and coaches in industrial game play. CEOs act as dealers, investors or sponsors. A Dane explained:

> But that is based on a long-term development of a good relationship…I know these people from before, and I can walk up to the CEO of XX and say: 'YY, give me 10 million, and I will make you happy, maybe.' Two things: he would laugh and say: 'You are funny.' Or he would say: 'That sounds interesting, tell me more.'

As in a poker-game, the above scientist presents selected cards in his possession to a known and trusted potential dealer. On the basis of their past interactions and performances, and what the dealer sees on the card, the dealer may reject the card or ask to see more cards. He evaluates the value of the cards and players, and mulls over sealing a deal. We noted game plays similar to the above in the U.S., where five scientists explained how contacts and relations with right industrial contacts help secure lucrative sponsorships unavailable via competitive NSF deals. As a dealer or investor, the CEO's interests are the valuable ideas that may come out of this research game; access to the public knowledge pool; the symbolic power of a star scientist in legitimating industrial knowledge; and the company's branding. The

dealer and the scientist accept the uncertainty of scientific endeavours, and are aware that the cooperation is not a guarantee for a win–win situation. As the game unfolds, one of the players can defect, steal tokens or "kill" the other at the right moment (Zagal et al. 2006, p. 25; Steinkuehler 2006, p. 201).

Politicians or government officials at relevant ministries serve as dealers or coaches. Indeed, ten U.S., five Danish, and five British respondents revealed how they enroll politicians:

> The original Plant Genome Project, a lot of that money, as I said, went to Arabidopsis but it was originally funded in such a way as it was supposed to be for Senator X from Y, who was a major leader, if not the, it probably would not have happened, that whole Plant Genome Project, if it was not for him….There is a big farm interest obviously in the Midwest and he happened to be on one of the appropriations committees….He was a major player in getting that Plant Genome Project going, but the corn industry had a lot of interest, and all of a sudden the guy said: 'You know how you mass a political base for support for something,' but then let us say the corn growers would put a lot of their energies behind getting this thing passed if you go: 'Where is the money for the corn?' You know what I am talking about. There was a natural pressure that goes from: 'Well, you have got Arabidopsis. Well, we are not going to eat Arabidopsis. We have got all this corn.' So these are the political realities.

As in coach-athlete relationships (Crust and Lawrence 2006, p. 38), the above scientist offers how mutual closeness and trust between scientists and some politicians is important. Trusted politicians coach scientists on the method of play, and provide support and feedback on how to play the game at the political arena. Also, they massage general public relations, and sponsorship dealings. Thus, scientists and politicians cooperate, and their interdependency in determining a winning outcome is clear.

Trusted journalists may serve as middlepersons that assist in branding or delivering a positive image of researchers and research fields in line with what the general public and sponsors want or expect from research. One Dane commented:

> If you have contacts to journalists, it is always very efficient. At the time when I was really, say, very much in the media, it was due to contacts to different journalists at leading newspapers and then you get your story into the newspapers, and there is suddenly, the whole thing is rolling. So make yourself visible, make your institution make you visible. It has something to do with your personality. So in the old days a researcher was just a researcher, but this is not the case anymore, you have to be a salesman, but it is also fun. Some of us think that is fun.

Thus, as in the relationship between the most successful Premier League clubs, star players and sports journalists (cf. Nicholson 2009; Cummings 2009), successful scientists or fields of research cultivate a positive media profile, with the help of trusted or receptive journalists. In the U.S., we were told how professional lobbyists deal with the media to provide positive coverage of their research areas. In Britain,

we were informed that "so-and-so" is married to a science journalist. In Denmark, two respondents noted how having contacts with trusted journalists helps them construct positive images that resonate with social expectations.

Trusted research council directors or professionals are also coaches or dealers. In their competition with rival scientific players, our respondents disclosed how they cooperated with trusted research council officials who, armed with key abilities and skills, coach or help respondents to steer the ball of research priorities towards their specific interests. One U.S. scientist offered:

> We e-mailed our contact at NSF and said: 'Well, we think there should be XX.' And she said: 'Well, we cannot just make XX. We have to have a competition.' So, I just said: 'Well, ok, I will write a RFP.'

Another U.S. scientist disclosed:

> In the old days I interacted with NSF, old days meaning early 1980s….I was on a panel called genetic biology, XX's panel…[W] e put our heads together and we basically de-funded all the old people…We removed the money from the top of the whole field of plant pathology, soil, all of the old fields of agriculture that were dominated by these, we just de-funded them…Out they went. It was really a good thing we did. That was fun. I felt like I was truly a part of my government then.

As in the on-line game Lineage (Steinkuehler 2006, p. 201), the above respondent revealed how they entered the territory of their rivals, took siege, stole tokens or "killed" them with the help of trusted research council officials. When looked through a conventional lens, the above actions could be considered as unethical and as threatening to the integrity of research. However, when we compare them with certain popular games such as Lineage, we can start to appreciate that this is the way the research game is actually played as it evolves and shifts in response to practical realities. Similar practices occurred in Britain:

> Every institution wants a member of their faculty on BBSRC committee because then they can drive that actually the science that's being done in our institution is definitely the best to be funded this week. And I can think of two examples where Oxford University one year and York University another year both secured disproportionately large amounts of money from research councils in one particular area. And interestingly enough, there were people from those institutions sitting on the committee. Now I don't think that's wrong, and I don't think that those people did anything illegal; it's just that they were very successful in driving, you know, the allocation of funds to their particular institutions, and if the person on the committee had been from this institution, then maybe it would have come to this institution. Everybody is the same; they're all vying to win these funds. So you would use whatever means, fair or foul, to ensure that you secure your funding.

Thus, as in Lineage (Steinkuehler 2006), the way the game of research is actually played is not determined by designed rules or regulations, as defined by classical or mode-2 accounts of research. New cultures emerge as sanctioned rules of the game

interact with broader human, social, or political economic norms. A respondent noted that:

> In the U.S. we have some very prominent figures in the plant biology field, and these individuals are quite remarkable: They are articulate, they are very bright, and they have a vision. And they are willing to push their vision. In the USDA NRI, it is XX basically and two or three of them that are at the top of the NRI and I mean I know that's true too in NSF, you know, there are shakers and movers and there are certain people that resonate with people who run these programmes and right or wrong their voices are heard a lot louder than anybody else's…I think also because the Congress, NSF in some ways is caught in the middle because they have to say to Congress: 'This is what we are doing new, this is the new result we found, and this is how it is going to affect science.' Shakers and movers are well able to articulate, they are willing to articulate, and so they provide NSF a script.

Thus far, by examining our respondents' thinking and practices through metaphoric theorization, we begin to see researchers as players pursuing a goal. We see rival players. We see strategic thinking and acting. We see selfish and greedy acts. We see scientists' noting that success is not only determined by their talents and skills but also by the abilities and resources of others they seek to cooperate with. Researchers use their abilities and resources accordingly in order to enhance their competitive edge. We see close relationships of trust and mutual interest furthering the interests of multiple parties such as scientific players, dealers, sponsors, middlepersons or fans. We see winners and losers. Winners attract and access money, trophies, power, and status. One of these trophies is the autonomy to pursue whatever winners think is interesting and important. Thus, a metaphoric theorization allows us to see that the scientific freedom to pursue researcher directed enquiry is something won by strategy, as distinct from something gained by merit.

When the Going Gets Tough, the Tough Get Going

As in the world of sports (Crust 2009; Crust and Lawrence 2006; Dweck 2006), our respondents also faced setbacks:

> Somebody…from the world of finance… [said to me] the total benefit to the UK economy from agriculture is less than *the cut sandwich market*. I think that's a terribly frightening statistic, if the whole of agriculture, that's arable, animal, if that does all less than the amount of revenue generated from *cut sandwiches* we are in big trouble, because government doesn't put any research funding into *cut sandwiches*. So I think with that in mind, I think that focuses your mind a lot and what we do.

Setbacks stem from the possession of abilities or cards that deal-cutters such as the financiers evaluate as worthless. While this can lower scientists' self-worth as players, mentally tough players see setbacks as challenges to surmount. They maintain focus, and seek possibilities for growth and opportunity. Setbacks, as in

many sports games, also result from contextual factors such as referee decisions, sponsor expectations, or even spectator noise. A young Danish researcher observed:

> You sort of all the time have to feel where you think policy is going. So right now, for my science, it is pretty clear that food quality is gaining popularity and politicians have been told by the people that they should focus on product quality, you should offer people quality food and so on. You should focus on organic production, alternative energy or this stuff. If you followed the election or the last three weeks up to the election, you can see that even the right-wing of the parliament are talking about alternative energy and climate change and so on, so it is really…getting very…important to work with health, food quality, environment and alternative energy and stuff like that….You've got to redirect your science now.

Also, setbacks can come from going behind a match-up with rival players. In the U.S., military, health and energy researchers were offered as the real rivals:

> The U.S. is an industrial-military complex. The society is built around it. Plant biology is an insignificant pimple on that giant elephant….The total amount of federal support for all plant biology research in the U.S. is about 1% of the NIH budget or something like that…Where the resources are, of course, is in the military, so in this country this year the military research budget…would be about 87 billion dollars and so there is no shortage of money whatsoever. There is a vast amount of money. The NIH budget is only about 32 billion and the DOE budget is only about 30 billion. 87 billion is really a lot of money, so what we have in the U.S. is of course an enormous distortion of priorities.

All scientists respond to these setbacks. While those with a fixed idea of the rules of the research game lost motivation and blamed referees, sponsors or rivals, our hardened respondents, like tough-minded athletes, saw setbacks as catalysts for exerting greater effort, learning or honing new tactics as demanded by the situation to secure a competitive edge:

> We know an awful lot about a small weed and…we're trying to find out, work out clever ways of learning how the things we've found out in this small weed could [be made socially useful]…That's the challenge of genomics at the moment…The reason why that matters is you have to look back to why the government gave us the money in the first place…It was very much based on going to them and saying, 'Genomics is going to be incredibly important because it's going to deliver all these benefits to society; give us extra money in order to do it.' And so one of the jobs I have is trying to find increasingly innovative ways of answering that question in a positive way for the benefit of the scientific community. But on the other hand, I also have to go to the scientific community and say, 'Come on, guys, I want some, some results, you know. I want to be able to go [to the government] and say that we've found something that's useful.'

Disguise was one such tactic that the current day research situation demanded. 80% of our respondents offered myriad practices that share similar characteristics

with acts of disguise in Disguise Games: "spin-doctoring, reinventing, selling, or repackaging" of scientific ideas. Thus, since the 1980s, fundamental molecular biological research questions that were light years away from tangible practical outcomes had successfully been disguised as the silver bullet for most social problems, and because of this, molecular biology secured disproportionately large amounts of money:

> Plant genetics was very uncompetitive at the beginning and very small, and it just became huge, and it is interrelationships to agriculture and huge money…It is monster money and monster politics involving grain, involving food, involving ethanol.

As a tactic, disguise helps researchers take on images that are wanted, expected or predicted by their spectators, dealers and investors. Indeed, our respondents described how, during the last three decades, *Arabidopsis* (a small weed) served as a model plant for crop and plant research, and was *the* research subject and method that determined grant success and publication acceptance for three decades (since the 1980s). Yet, in media, policy and public debates, this very fundamental research that was light years away from tangible practical outcome was disguised as the "silver bullet" solution to most agricultural problems. As a result, it attracted lucrative resources that enabled *Arabidopsis* scientists to pursue the goals established by star *Arabidopsis* scientists. In the U.S., the predominant examples of this disguise were NSF's Genetic Biology, Plant Genomic and 2010 Programs. Accordingly, disguising classical biological research questions as molecular research questions was offered as a game tactic by classical biologists.

By the end of the last century and early in this century, sponsorship momentum started to shift due to new forms of setbacks—paradigmatic shifts from genome to systems biology and in global politics—that questioned the worth of investments in model plants, and indeed, plant genomics in general. A star U.S. respondent offered:

> 30% of all farm income is subsidy so it is very difficult to go to the politicians and say: 'We have a desperate need for more research in plant biology.' I in fact had the experience of having a politician tell me: 'That is just more money down a rat hole.' You make more of it. We need more over-production; we need more subsidies, right? This is the basic attitude, and so finally I think we can see that there are other pressing reasons they understand in plant biology, even from an applied perspective, and so that probably will, or may create some change in the funding scene, now that you can see plant biology as a kind of solar energy…Bioenergy aspect is much more promising in that respect.

In response to new setbacks, scientists invented new forms of disguise: bio-energy, bio-economy, food security, sustainable agriculture, bio-security, nanobio-technology, etc. The new methods of disguise were coached by the new bio-energy industry (owned by farmers) lobby, in cooperation with hardened star scientists. A senior U.S. scientist offered:

> XX was also a major voice when DOE, DOE ran some workshops on their future directions, and there was input from different people on where they should be going and he and others like Y and other plant science guys that were part of that. But X had an incredible input into it. It ended up, okay, so there was a scientist saying that this is an area of opportunity that we ought to get behind because of bio-energy and that kind of thing. Then there is the politics that came in and says: 'Wow, where is our energy security happening here? Where is that going to go?' And then you had the Bush Administration backing it, and asked DOE what are you going to do, and X and other plant guys were in there at a time when they helped shape the call for proposals for the LL…I would say that the actual areas where things went was shaped to a large degree by scientists and with leadership from XX and some others and then the political side ended up bringing in the pressure to actually allocate dollars to the area, so there was a meeting with everybody.

Denmark and Britain took cues from America. As in the U.S., energy security, terrorism, climate change, or nanobiotechnology were offered as the latest forms of disguise. In Denmark, the new forms of disguise secured the support of enzyme producing companies that, in return, lobbied government or sponsored bio-energy research programs.

The game "Wolf in Disguise" simulates shepherd dogs to protect their owners' interests. Similarly, in the U.S., scientists used corn-growers' associations, local senators and governors to "shepherd" their interests. In the U.S., a respondent explained:

> You know, sort of put on pressure. You know, [scientists] making, contacting, so this is where the community makes an impact; it just goes and starts contacting legislators and liberal staffers typically, but sometimes directly through constituent visits to people like Senator XX or others. You know, people who are on government committees that have direct, you know, input and impact, and I think we would be in much worse shape right now, if the last two years people like X and others had not been doing that kind of thing.

In Denmark, we were told who the shepherd dogs were for the Danish biotechnological research programs, bio-energy, or nano-technological research programs, and in Britain, for the BBSRC crop science or systems biology programs.

As in the world of sports, utilization of professional lobby organizations is an important tactic, so lobbying for funding is assigned to professional societies that are also responsible for public relations. Examples given were the *Arabidopsis* community, the American Society for Plant Biology (ASPB), the Federation of European Biochemical Societies (FEBS), Plant Biotech Denmark, and the GARNet network in Britain. Indeed, in the U.S., we were told that ASPB has a professional full-time lobbyist who, on behalf of the community, lobbies congress, state governors, industry, public and financial communities. The lobbyist also coaches scientists on how to lobby their respective state governors; for example, the lobbyist arranges a meeting with a state governor. Beforehand, the lobbyist holds a meeting with scientists to discuss the best strategy for communicating with the governor.

After the meeting, the lobbyist holds a meeting with scientists to discuss how they succeeded at playing the game and proposes future tactics.

As our respondents indicated, researchers employ tactics such as disguise, shepherds, and lobbyists because the outcome of the scientific game, as in most games, is uncertain. Certainly, as our respondents indicated, most research will always be useful because it develops scientific understanding and, when excellent, affects other scientists' work, expands scientific boundaries, or leads to useful social applications. However, respondents emphasized that it is impossible to predict in advance the outcomes of a research game. Human limitations, skills, creativity, luck and serendipity all play a part in rendering the outcomes unpredictable. A leading British scientist confirms this uncertainty:

> Nixon demonstrated that in the great 'we will cure cancer' thing. You can't do that; you can't say, 'okay, well, here's some money; go out and do this.' You can say: 'Here's some money; go out and do good science in this area and let's see what the hell comes out of it.' But you can't set it up as a—it's not a factory floor, and that's the real challenge that research councils and RCUK, and I suppose to a more limited extent riff-raff like me have got, is to try and ride the punch set-up systems that are resilient, that acknowledge the political actuality but still allow that breadth of creativity that you know because, in the end, that's what's going to deliver.

Thus, disguise, shepherd and lobby tactics emerge at the intersection of myriad factors, which call for innovative measures for surmounting scientific, social and economic contingencies. When we interrogate research practices by way of the game metaphor, we begin to see, contrary to mode-2 notions (Nowotny et al. 2001), how the game of research is always in the process of becoming. We can see, too, that the game of research cannot be reduced to fixed rules or regulations. It is a dynamic game, and the actual practices and rules of the research game shift according to shifting contextual parameters.

Our respondents indicated that they are resilient, tough, skilful, judicious, and successful at devising tactics that surmount most setbacks. Also, they were reflective and aware that their utilization of ever emerging tactics amplified the unpredictability of the outcome of the research game. Citing bio-fuels, 50% of our respondents considered how disguising fundamental plant science as bio-fuels research may well be well beyond what is acceptable. The game regulations allowed this tactic, however, and scientists were optimistic that as long as one scientist delivers a decisive hit now and then, sponsors, or fans will be happy and continue to support them.

On their part, scientists or scientific teams that bring a decisive hit home become the superstars that gain prestige, funding, trophies, power and resources, assuming god-like star status whose game plays may redesign the future practices and rules of the research game. That is, they define the science that deserves funding and publication; indeed, they decree what is open, closed, or doable science for the majority of the scientific community. One of the trophies that winners bring home is freedom and autonomy to pursue what they consider interesting and important. As game momentum shifts, under-performing squads and majority of research gamers

shift their practices accordingly. Thus, their freedom or autonomy comes to depend on the leadership styles and abilities of the winning stars. Thus, through our game imagery, we see that freedom and autonomy to pursue enquiries of interest as something that scientists win by strategy, as distinct from something gained by merit. Also, we see decisive discoveries or socially useful outcomes of research as resulting from an intersection of talent, skills, hard work, resilience, chance and luck—as distinct from hard-core rules or controls.

Interactively Stabilized Collaborative Games

Indeed, as in on-line games such as Lineage (Steinkuehler 2006) or imperfect collaborative games (Zagal et al. 2006), we observed evidence that the game of research cannot be reduced to hard-core rules, or the dichotomous thinking provided by mode-2 or triple-helix theories of science.

Thus, with reference to new rules for greater academia-industrial collaboration, 70% of our respondents claimed that they accommodated this rule, and formed what we will define here as *double-helix teams*. Our respondents said that although initially they expected all players to endeavour to be better teammates and to further genuine collaborative practices, reality taught them how industrial players act selfishly, prey on scientists, and steal or capture their tokens. One U.S. scientist offered:

> In our YY project we have a corporate partner. XX and I are really naive and we just….[spill] our guts and tell them everything. We found out later that actually some of the stuff that we presented to them they patented it. And that was really a shock to me. And then other things we take: 'Oh how do you do that?' We were given a certain task, so we went back to them and said: 'You guys are working on this too, could you just tell us what you are doing?' 'Oh we'll send you some; we'll give you something blah blah blah.' But of course they never did, worse, telling everything, everything out and it is really interesting now because XX has become a completely different person, I mean he used to be: 'Oh yeah tell them everything, give them anything they want.' Now it is like: 'No, no.' It is sad.

In Denmark, a leading scientist noted that, "They [industrial players] expect to be fed like a pigeon: 'Feed me, feed me with knowledge.' But they do not give anything back. They do not enter into a dialogue." In Britain, respondents noted that industrial players pay little consideration to collaborative teams' common interests or goals, or scientific players' interest in publication. For example, industrial players had terminated collaborative contracts even in the middle of a game.

Yet, 70% of our respondents stated that they were open or active members of emergent *double-helix teams*. Certainly, as one form of research game team-ups, *double-helix teams* are as old as science. However, although the rule for enrolling in *double-helix teams* was enforced by governments, respondents argued that their enrolment was driven by factors beyond these directives. They offered that *double-helix teams* are fun and generated lucrative economic and material gains. Indeed,

they discussed how they struck "free money" or "the freest gift that a university will ever receive from a company," which was impossible to obtain elsewhere. One leading U.S. scientist offered:

> I got over $100,000 a year. Maybe, and at the time it was a lot of money and that allowed me to change fields. That is the truth and it allowed me to do it. It picked up about a quarter of my lab's budget…It was just what I needed to change fields, to cushion my lab, to keep the pubs rolling and to come out in the end, after much worry, funded and in a new field…Of all that money they did not get one patent, but they did allow some professors to use it wisely…This is a release from the pressures of funding during the mid-age period, and I do not think I could have done that with the pressure to compete at this 8% [grant success rate]…I know for a fact that I would not have done it [changed fields]. I would not have had the courage to just have no money for a period of a year or two. I get nothing from here [the university].

In Britain, a real *double-helixer* who had experiences with no less than 10 biotech companies said that *double-helix team-ups* provided his group with funding that was difficult to access from competitive research council deals. He added that his group accessed state-of-the-art equipment and brought in money that helped finance post-docs. In Denmark, a leading scientist noted how his group sealed a 10 year deal with corporate sponsorship to undertake basic research. It was this deal, he disclosed, that gave his group the opportunity to pursue fundamental research without worrying about money, short-term accountability or control instruments that, according to all our respondents, frustrate scientists and hinder scientific peak-performances today:

> We are very close to getting a nice sum of money from the industry. Free money, where we can do what we want to do, because they agree with us that 'you guys just need to be able to go ahead with these ideas that you have, because they are so important for us in the long run, and we need someone to do it, and we agree with you that you cannot get that public funding for that. It is so hard to get, so we just give you the money upfront.'

Double-helix teams' sponsors, this respondent offers, do not only sponsor scientific players, they support and believe in free and autonomous enquiry. He and others also discussed how *double-helix team-ups* opened opportunities for translating basic research into useful applications—opportunities that are impossible to acquire in university team-ups. One star U.S. scientist and member of myriad *double-helix teams* stated:

> We are not very interested in incremental, short-term work, because I believe and my partners believe that the path from an academic discovery to a useful innovation is quite long, and anything that is just an incremental improvement on today's technology, there is no hope of it ever moving from the university into a company, because some company will surely discover it much more quickly….What we do in the universities has to be far, far away from any commercial thing, but even in a start-up company, all these start-up companies, from the time they start until generally I think their first product

> is a success, I think it is about 15 years on average, so university research has to be even further back than that, or at least that far back. And so one of the things that is wrong with all government support for university research is that accountability is not based on the right time frame. It is really a long time.

Ensuring decisive practical outcomes in the game of research, our respondents offered, takes huge capital investments, market and commercial infrastructure insights, which translate fundamental discoveries into useful or marketable products. Contrary to triple-helix theories that celebrate commercialization of public university research, 80% of our respondents expressed that, initially, they were open and eager to make selfish or competitive strategies: patent discoveries or valuable findings, as allowed by new rules of the research game. Especially in America and Britain, which have longer histories of commercialization rules than Denmark, respondents said experience with making competitive moves taught them how difficult it was to get industrial groups interested in investing on patented tokens. As we noted above, they realized sole players or university teams cannot translate basic discoveries into commercially viable and competitive products in the market. They noted that the legalities of patenting consumed too much time and financial resources that are unavailable in universities. Respondents explained that patenting or spin-off strategies drain paper and grant productivity. On the one hand, although many stated that such setbacks discouraged utilizing patenting strategies, they said that they still eyed opportunities that would make them David Beckham. On the other hand, a Dane and two Britons explained how patenting setbacks were resolved by covert (secret agreements) tactics:

> Certainly none [patent] that I've been involved with have actually made money. The only things we've made money from are things that we've kept secret and sold on a secret basis…The difference is that by patenting it you're publishing it; and if you have something which is very difficult to monitor its use, then by patenting it you make the whole process accessible to anybody that wants to use that. And if you can't monitor their use, then you can't protect it. So one way to protect it is not to patent it at all, to avoid all the costs of patenting.

Reasons for enrolling in *double-helix teams* went beyond material gains, however. For example, respondents described industrial scientists as real talents. They noted, too, that the *double-helix teams* provide opportunities for learning industrial skills or tactics. For entrepreneurial respondents, well exemplified by an American and a Dane who had founded spin-off companies, *double-helix teams* provided possibilities for growth by providing new opportunities for networking and building business partnerships and capital investments for their spin-offs. They also provided market and commercial infrastructure insights and opportunities that were otherwise unavailable.

By seeing the act of enrolling in the *double-helix teams* as part of the research game, scientists have come to see obstacles or conflicts that they face in *double-helix teams* as challenges to be surmounted, while opportunities provide valuable incentives that stabilize the game play. 20% of our respondents condemned *double-*

helix teams as amoral and threatening the integrity of the research game. Indeed, *double-helixers* were aware of this criticism: "I was the poster child of [double-helixing]… so on my website I kept saying, 'the % of my lab that is funded by industry is [xx], how much I am bought.'" However, this and other *double-helix teams* saw critics as rivals. They claimed that research game practices and rules evolve and change in unpredictable ways, opening up new opportunities and possibilities, which currently included much needed "free money." Echoing Shapin's observations (2008), *double-helixers* insisted that as scientific gamers, they are too egoistic, stubborn, individualistic and driven by the desire for free play or an adrenalin kick to be controlled by anyone. While some claimed they did not care about their industrial players' interests, some noted that the *double-helix teams* offered industrial players access to public university knowledge reservoirs, legitimization of industrial knowledge, and when successful, the lucrative trophies or tokens of patents or valuable knowledge.

The *double-helix teams'* sponsors, our respondents said, provided more scientific freedom and autonomy than government or research councils:

> They [government] want to control….The excuse is that they want to get value for the money….They try to implement that system in a scientific community…If you want creativity, if you want new ideas, new thoughts, they are not doing the right way…Basically what every scientist would like is just: 'Leave me alone. Give me some money, leave me alone, and I promise you will get a Nobel Prize in 10 years…' But it is getting worse and worse and worse I would say. It has gone beyond the point where it is good sense. Now it is 'the more management, the better. The more control, the more results you will get.' No! The lesser results you will get!

Resonating with Shapin's (2008) observation, the above Danish scientist and others insisted that trusted industrial CEOs or research managers share similar beliefs and interests with university players, especially the belief that free research is where valuable discoveries are made. Although he and others accepted that they face myriad obstacles as members of *double-helix teams*, they rejected the notion that *double-helix teams* are essentially or necessarily worse teams than pure university teams, or a threat to scientific freedom and autonomy. If anything, lack of resources due to low grant-success rates or bad leadership, referencing and management were offered as the real threats to scientific integrity and success.

It is in response to these game setbacks that the research gaming community is in a perpetual state of development to maintain their fitness relative to the systems in which they play and evolve. As in certain games (such as Lineage), emergent research practices or cultures are always in the process of becoming. As their surrounding system evolves, scientists must surmount accompanying setbacks. They do so by, for example, adjusting their interpretation of what *double-helix teams* are and mean, and develop more realistic and flexible expectations and understanding of their own abilities, values, talents, and self-beliefs. Thus, scientists adjust their views and expectations about industrial players and sponsors, developing pragmatic relationships and an understanding of the abilities, skills, talents and resources of rivals. Scientists exploit these opportunistically and accordingly. As in most games,

the goal is to win, and in this game, to be the first to strike a valuable discovery or knowledge, and be the first to publish it as a high impact paper in a high impact journal. Ultimately, it is the decisive win that provides a springboard for generating economic resources, prestige, lucrative deals, trophies, top-flight status and relations of power, which are part of the research game.

Conclusions

This paper engages with the metaphoric imagery "research is a game," observed in our field engagement with American, British and Danish crop and plant scientists. Taking cues from this observation, we theorize our respondents' subsequent thinking and practices metaphorically as a game.

Our findings support Calvert's (2004, 2006) "tailoring" concept and Morris' "playing up" or "putting it in a climatic coat" (Morris 2000). They support Vallas and Kleinman's (2008) study that observed scientists constituting both industrial and public-university-associated practices. They support Shapin's (2008) notion of normative uncertainties that capture how both personal and impersonal virtues influence the dynamics of knowledge production and how scientific, public good and private virtues shape scientists' practices. Thus, and in line with these scholars, we move away from the dichotomous thinking provided by classical, mode-2, and triple-helix accounts.

We build and extend this literature in a number of ways. We engage with scientists' *talk*, which we theorize through a game perspective, drawing upon social science game scholars that see games as more than their rules—as always in the process of becoming, and as calibrated and contrived by contextual contingencies that generate emergent practices and interpretations. Thus, we conceive the classical or mode-2 rules of research governance as in dynamic and interactive tension with researchers' goals and actual practices, and with social and political-economic actors' goals and actual practices. These goals and actual practices generate emergent opportunities or setbacks. Scientists exploit opportunities and see setbacks as challenges to surmount. They surmount setbacks by, strategically, seeking cooperation with the "right" players, sponsors, dealers, middlepersons or coaches. Conversely, they employ tactics such as disguise, shepherds or lobbyists; they even team up with rivals. As players, the goal is to win, namely, to be the first to strike a decisive hit, that is, a big breakthrough, or a valuable discovery and be the first to publish it in a high impact journal. Winners amass high status, high-value, prestige, lucrative deals, trophies, relations of power and resources, turning into superstars whose game play and coaching practices may redesign future practices and game play, thus defining the science that deserves funding and publication and decreeing what is open, closed, or doable science for the majority of the scientific community. Consequently, winners enjoy enormous freedom and autonomy. However, on the one hand, losers and non-winning research gamers shift their practices according to the winner's game play, and their freedom or autonomy comes to be dependent on the leadership styles and abilities of the winning stars. On the other hand, losers respond: they learn and hone new skills and tactics, and their emergent practices and

outcomes may sustain or change the game play. In turn, winners respond to losers to ensure their status as victors. So, and from a game perspective, social demands and expectations are setbacks that scientists seek to surmount. The public are fans or spectators. Government, industry, NGOs, research councils, politicians or journalists can act as owners, sponsors, dealers, coaches, or middlepersons. Scientists play hard for autonomy, scientific freedom, and the power to shape the game play. Also, decisive scientific breakthroughs or socially useful outcomes are always uncertain events that occur at any given moment of the game, as a result of the intersection between talent, skills, hard-work, resilience, abilities, commitments, persistence, chance and luck, time and resources—as distinct from hard-core rules or controls. That today popular games may serve as models for research thinking and practices may be what is new and different in the shifting regime of research governance. Perhaps more importantly, scientists explicitly acknowledge that research is a game in ways heretofore unacknowledged.

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