Gender Differences: The Role of Nature, Nurture, Social Identity and Self-organization

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Abstract. This paper describes an agent-based model to investigate the origins of gender differences in social status. The agents' basic behaviour is modelled according to Kemper's sociological status-power theory. Differences in the socializing forces of the surrounding society are modelled using Hofstede's dimensions of culture. Particulars of play behaviour are modelled using experimental child development studies from various cultures. The resulting model is presented and discussed. Social identity as a group of either non-gendered children, boys, or girls, seems a powerful force, multiplying the effect of biological differences. The model is actually general enough to be applicable to a wide range of social behaviours with minimal changes.

Keywords: Agent-based model · Gender · Aggression · Rough-and-tumble · Social identity · Status-power theory · Culture · Self-organisation · Emergence

1 Introduction

"Poor Toby! He was so eager to join the big kids in their evening games of Capture the Flag and Kill the Pill. It's a great tradition among the kids at the marine biology lab where we've spent many summers. But little did Toby know that he would soon become "the pill". He came home in a fury, bruised, crying and as angry as I've ever seen him. Luckily, his injuries weren't serious, but when I interrogated him to find out who'd done this, the real source of his rage became clear. It wasn't all the tackling and roughhousing he was upset about. It was that he'd been beaten by… a girl!" [7] (p. 264 – Toby is a ten-year old US boy, the author is his mother).

In all the populous societies in the world, there is a degree to which men receive more status or wield more power than women, according to various criteria such as visibility in public life, representation in well-paying jobs, sexual prerogatives, violence and crime rates. The difference could be small, as e.g. in Sweden, or large, as in Saudi Arabia. It could be generally accepted, contested, or denied.

Our concern in this paper is to explore whether an agent-based model about the micro-dynamics of play between pre-puberty girls and boys can throw light on the

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origins of gender differences in power. We concentrate on children under the assumption that they may come closer to a 'tabula rasa' than do grown-ups, that their behaviours may be more guileless and observable, and less affected by external circumstances, than those of grown-ups.

What are the main possible influences on these differences? The traditional opposition is between 'nature' and 'nurture'. The 'nature' point of view is that biological differences between the sexes cause the power balance – or imbalance, if you will. The 'nurture' point of view is that gender differences are a product of socialization. At birth, socialization has yet to begin. Boys are slightly bigger and fussier at birth, but parents react in vastly gendered ways to their babies' sex, even before birth. The opening quote about Toby shows that by ten years of age, children can be keenly aware about gender and its status aspects.

Agent-based models allow exploring the interaction between nature and nurture in a process of self-organization or emergence. This means the gender differences could start small but be enlarged to various degrees in various societies by interaction with those already socialized into the mainstream culture, and by the institutions of that culture.

In this article we describe an agent-based modelling framework to investigate the roles of nature, nurture and self-organization for the emergence of gender differences. We model a mixed-sex playground with ten-year old children and some minimal prototypical interaction activities, and look at the emerging patterns of interaction.

The model requires several types of theories as its foundation. This is important because we aim for a generic model of social reality, of which the playground example is just one instantiation. First, we need a theory that tells us what motivates the children. We selected the sociological status-power theory by Kemper [19], for its simplicity and universality. We supplement it with notions from Tajfel's Social Identity theory [28]. Next, we need a theory to span the cultural spectrum of socializing influences. For this we took Hofstede's [13] dimensions of culture because they are the society level indicators with the largest nomological network, i.e. validity. Third, we need to use specific theory on child development and play. Here we use a variety of books and articles, with a central role for Eliot's recent study [7].

The core elements of Kemper's theory are highlighted in our choice of concepts. First, Hofstede's work on culture shows a strong influence of the dimension of masculinity-femininity on comparative gender status. This dimension actually distinguishes status-based versus power-based social organization, and fits Kemper's framework well. Hofstede [15] argued that the same distinction was found to be important for social organization in non-human primates by Hemelrijk [10, 11] in agent-based models of dominance interactions. Second, there is ample evidence from child development literature that points at important roles of both rough and tumble and fighting for hierarchical relations between children within and among genders.

The bodies of theory used are briefly introduced in the next sections. After this we explain how they are used in our agent based model. Because that model operationalizes agent behaviours such as playing and quarrelling, it also requires variables and mechanisms that the theory does not specify. After a summary of the research questions in the second section, the third section describes our design, including links to the theories. After that the results of preliminary simulation runs are presented and conclusions are drawn for further work.

2 Research Questions

We are investigating the emergence of differences in status across genders, and the emergence of specializations in social role among boys and girls. To do this we consider a number of possible causal factors:

- biological, innate differences between boys' and girls' characteristics, assuming individual variation;
- behavioural differences between the sexes, again assuming individual variation, and in belief update,
- differences in social identity between boys, girls and 'generalized children', as apparent in penalizing or rewarding certain behaviour;
- cultural influences on the previous factors;
- self-organized ('emergent') outcomes of interaction.

The means to study these questions is a simulation that allows varying the first four of the above factors. This modelling exercise creates two levels of aggregation: the individual children (agents), and the simulated world (playground). Based on variations in the agents and the rules of interaction, different gender patterns can occur. We build the agents in this simulated world as faithfully as possible based on the theories that we selected, create rules for the agents' interaction as far as possible also based on these theories, then run the simulation to study the results at system level.

We created one version "boy-girl" in which reference groups are simply modelled by a systematic bias in favour of the gender with the highest average status, and another one 'ref-group" with full-fledged reference group logic. At the time of writing, we managed to test the first much more thoroughly than the second version. The paper therefore deals with the boy-girl version unless otherwise specified.

Our main hypothesis is that the effect of nurture (operationalized through culture and reference group norms) will dominate the effect of nature (operationalized through kindness, beauty and power). In particular:

1. Social status will correlate with kindness in feminine cultures.
2. Social status will correlate with power in masculine cultures.
3. Rough-and-tumble will boost social status.
4. Categorical differences in status accord based on gender will enlarge any tendency to gender-based status differentiation.

3 Theory Base

3.1 Status-Power Theory

US sociologist Theodore D. Kemper [19] proposes that our social behaviour revolves around the concepts of status and power. It could be summarized as "Make status, avoid power".

Status as Kemper uses it is not just a pecking order variable, though it includes that element. It is something that we continually both claim from one another and confer upon one another through our actions. An example may illustrate this. If, at the office,

I greet Linda upon entering her room unannounced, I confer status on Linda; how much will be determined by the modalities of the greeting. My choice of greeting will depend on things such as our hierarchical and personal relationship, what preceded between us, my personality, the nature and urgency of the issue at hand, and whether others are present. At the same time, by entering unannounced I make the status claim of being somebody entitled to enter Linda's room. Formally, status is the voluntary compliance with the wishes of another.

Power comes into play when we want someone to do things and they do not voluntarily comply: we can then coerce them in some way, by pleading, lying or violence. Many actions have both a power and a status component. For instance in our example, if Linda does not want to confer status upon me by hearing me, she could look up, say "Excuse me, but I'm, very busy, could you come back later?" and then resume working; this might be a status move, indicating that I have not enough status to enter. I'd probably also interpret Linda's action of resuming work as a power move – I would have wanted Linda to continue looking at me to hear my reason for entering, and I expect Linda to know this..

Reference group is another important notion in Kemper's theory. Sociologically speaking, our actions are influenced by a committee of reference groups.. Sometimes this can be quite complex; e.g. when the greeting rules from the tennis club, where I play in a team with Linda, differ from those of the office, which ones to use?

Kemper's theory posits that people attempt to maximize their status while protecting themselves from the power of others. People are also driven to confer status on the deserving. Status is earned by a proper dose of status conferral upon others, refraining from over-claiming status with them, and using power in ways backed by authority granted by the reference groups.

3.2 Social Identity Theory

In accordance to reference groups in Kemper terms, Social Identity Theory [28] has some elements that can be used in our simulation. It states that part of the self-concept is built in terms of membership of social categories. Social categories define a set of features that drive and regulate conduct of behaviour of its members. These features represent the ideology, such as values and norms, that members should follow, therefore sustaining a frame for status worthiness. A member that behaves according to the ideal is worthy of status, but one that deviates is blamed and disregarded.

The influence that a social identity has on the behaviour of a person depends on how salient it is in a situation. The theory postulates that certain situations, such as the presence of an out-group, make social identities more salient, thus raising the influence of its ideology in the person. In such cases, the person behaves more like a member of the group and less like an individual. In addition, the strength of this effect is related to the emotional commitment of the person to the social identity. A person is more likely to activate a social identity if (s)he is positively committed to it. The commitment, as well as the construction and identification of the ideal into one's social reality, comes from experience and socialization processes.

The social identity defines a frame of social structure as well, including status order and social relationships. By activating different social identities the social structure changes as well. This partially explains why certain approaches to Linda, of the example in the previous section, may work in the tennis club and not in the office. It could be the case that according to the social identity that is salient in the office the status difference is higher than it is in the frame of the social identity that is salient in the tennis club.

3.3 Cultural Dimensions of Values

For the cultural component of our model we follow the theory of Geert Hofstede. In the most recent version of that theory [13] there are six dimensions of culture, each of which represents one of the big issues of social life that the members of a society have to contend with. The associated dimensions are bipolar continua, on each of which each society takes a position. These societal traits are not to be confused (but, alas, often are) with personality traits such as those found by McCrae et al., although there are national-level correlations [14].

If social life revolves around status and power, then this should be reflected in dimensions of culture. We would expect different societies to have different propensities to use power, for instance; power sanctioned by a society being known as authority. The dimensions point to systematic differences in how the people in a culture tend to act – thus both enacting and perpetuating their culture, and sometimes modifying it.

In what follows we present each dimension of culture in Kemperian terms.

Individualism. Individualism-collectivism is a society's specification for the unit that has the right to claim and receive status. In an individualistic society, individuals are the units. In a collectivistic one, groups are.

In an individualistic society, there will be more reference groups, differing in their reach of control over the agent's mind. Ideals in these groups might include heroes, friends, or one's nuclear family members, deities and fiction characters. In a collectivistic setting, one inclusive reference group, the extended family, clan, or people, is likely to take priority over the others.

Power distance. Large versus small power distance is the willingness to accept status and/or power domination. It is about voluntary status-accord and granting of authority, based on ascribed characteristics, not on actions. The net effect is that default status-accord in an interaction will be asymmetric: participants will seek to find out their respective status, and if they deem themselves inferior in ascribed status, they will give way. Some status markers are age and gender. Note that the term 'power' in Hofstede differs from Kemper's 'power' In this paper we follow Kemper's meaning except in the name of the 'power distance' dimension of culture.

Masculinity. Masculinity versus femininity is a preference for either power-oriented or status-oriented social relations. It is about voluntary status-accord to others based on their performance in competitive settings – in other words, based on their power *sensu* Kemper. The net effect is that people in interaction tend to seek status either by winning

competitive sequences, or by aligning themselves with powerful 'winners' (presidential candidates, deities, sports heroes). The converse, femininity, stands for voluntary status-accord to those who refrain from using or showing power. A feminine culture may also penalize overt power moves and status displays.

Uncertainty Avoidance. This is the degree of anxiety in a culture in relation to strange things or unfamiliar situations. It leads to status conferral on the familiar and status withdrawal from the unfamiliar.

Masculinity-Femininity and gender roles. The Anglo-saxon and Scandinavian world are culturally much alike but for the dimension of masculinity – femininity. This makes them comparable to Hemelrijk's despotic and egalitarian macaque societies, as proposed by Hofstede [15]. On average, men hold more masculine values than women, confirming the 'Mars – Venus' hypothesis. Curiously, there seems to be a tendency for women in more masculine societies to more often achieve prominence in the pecking order in companies. In masculine societies, career women hold more masculine values than other women in these societies [13]. This probably reflects a selection process: women without such values quit the rat race. In political life, the trend is different: in government, women are more numerous in feminine societies than in masculine ones. The difference between business and politics is that in business, women are promoted by co-optation: existing alpha persons, usually males, have to accept newcomers among or above them. In politics, the anonymous voting system can promote women to the top. In the Netherlands, a country with a very feminine culture, the trend for women to be less prominent in business than in politics is clear.

3.4 Empirical Studies of Child Behaviour

Infants. Brain scientist Lise Eliot made a grand sweep through the literature on gender [7]. Her conclusion is that at birth, biologically speaking the variation within each sex is a lot greater than the differences between the sexes. The only reliable difference at birth is that boys are a bit bigger and more active. A meta-study of 46 studies [3] found boy babies to be 0.2 standard deviations more physically active than girls.

In contrast to the small biological differences found at birth, socialization by parents shows obvious and large effects. Haviland and Malatesta [9] show that when baby girls were cross-dressed as boys, observers were more likely to ascribe anger or distress to them, and vice versa. In another study with 3- to 6- months' old New York babies and their mothers, Haviland and Malatesta found that mothers showed a conspicuous lack of responsiveness to their baby sons' expressions of pain, as well as to their baby girls' expressions of anger [22].

Aggression. Starting at about age 4, boys are found to be more physically aggressive than girls [24]. For some time, this finding led to reduced attention to aggression in girls, until it was found that girls used 'relation aggression' more, such as exclusion from peer groups.

Crick assessed aggression and prosocial behaviours in a school in the US Mid-West. Physical and relational aggression and prosocial behaviours were found to be

separate behavioural categories stable across time. Children that were aggressive and lacked prosocial behaviours developed social maladjustment [5].

Lansu [20] investigated popularity and aggression among 10–12 year olds. Popular peers evoked subliminal avoidance response in a joystick task. For unpopular peers, the response was gender-biased: girls evoked approach, whereas boys evoked avoidance. In a second study she found that popular peers attract unconscious attention, especially from other popular peers. Popular boys especially attracted attention from girls. A third study investigating explicit likeability and implicit avoidance/approach found the following (ibid. p. 164, or see [21]):

"Prosocial adolescents were evaluated more positively, and evaluated others more positively, on the explicit likeability ratings. There were implicit effects for aggressive girls. Girls who were known for their bullying and relational aggression such as gossiping, ignoring others and excluding others evaluated their peers negatively at the implicit level. They tended to avoid their peers in the joystick task. Aggressive boys did not show this tendency".

Lansu carried out a fourth study that showed adolescents to be on their best behaviour when interacting with more popular peers in a discussion task.

Rough and tumble. Rough and tumble (R&T) is defined as "a physically vigorous set of behaviours, including chasing, jumping and play fighting, accompanied by positive feelings from the players towards one another" [6, 17]. R&T is found among all human cultures and more generally among non-human primates, as well as other social mammals and birds. It happens a lot in peer groups of children, such as one finds on playgrounds. R&T involves reciprocal behaviour often observed in role change, such as chasing and being chased [26]. Jarvis [17] cites a number of studies that find R&T to involve much social learning, particularly among male primates. A very robust finding is that R&T is more common among boys than girls [6, 27, 29, 30]. In her review DiPietro [6] found R&T to occupy for 3%–5% of play time at preschool time, 7%–8% between 6–10 years of age, and to peak at 10% between 7 and 11 years. It then rapidly fell to 5% at 11–13 years and 3% at 14 years, to almost disappear in adulthood.

R&T can lead to enjoyable play, or it can lead to fighting. Anthony Pellegrini, in a South-eastern US school with children aged 5, 7 and 10, found that popular children's use of R&T was positively correlated with social problem solving [25].

Children who engage in R&T tend to be friends, and tend to be of equal status, until adolescence when slightly stronger children approach slightly weaker ones [16, 27]. Together with the finding that among all human cultures, as well as among non-human animals, males do more R&T than females, this suggests a role in preparing for sexual selection.

The line between rough-and-tumble and aggression is sometimes a contested one, as shown by RuthWoods [31] in an ethnography of a London primary school. Girls will claim aggression where boys claim friendly intent.

Culture. It can be assumed that biological sex (boy or girls) and norms for behaviour (boyish or girlish) are correlated to a degree that varies with cultural masculinity. The research on children so far has almost entirely been from culturally masculine societies. This is recognized by some authors. Hilary Aydt and William Corsaro, for instance, comparing preschool children from Italy (Bologna and Modena) and the USA (African American and white American), say (p. 1309) "we can infer that the level of

segregation of children would vary according to the degree the adult culture considers men and boys to be aggressive and women and girls to be passive" [1].

Do child studies from Sweden, the world's most feminine society according to the Hofstede database, yield a different picture? Evaldsson [8] studied 11–12 year-olds in a multi-ethnic school in Sweden. The immigrant children at the school were fluent in Swedish and had been there for 3–7 years. The environment was decidedly culturally feminine: "In contrast with American school settings (…) girls' participation in team sports such as handball, basketball and soccer were promoted through physical education classes in cross-sex groups during school hours and same-sex sport clubs outside school" (ibid, p. 479–480). Evaldsson found that when playing foursquare, girls used 'slams' freely with boys but would 'throw like girls' to physically less skilled girls. Cross-sex games were quite common. She compares her findings to those of Thorne (1993) in the USA: "In contrast to what Thorne (p. 67) found, cross-sex games such as 'boys against girls' remained relatively stable and often lasted for several weeks. (…) The boys did not enter the girls' groups with the intention of disrupting the game, as Thorne found (…)".

Even in this gender-egalitarian atmosphere there was still a degree of gender separation; one group of 10–13 year old boys played football with only occasionally girls joining, some less physically skilled girls avoided mixed-sex games, and some less physically skilled boys avoided boys-against-girls games. Also, symbolic gender identity management took place. In particular, physically unskilled boys were discounted by the other boys, so that only the skilled ones became representative of the social category of boys (p. 493). Generally however, it was clear to these children that "differences in physicality within the girls' (and the boys') group were even greater than the differences across the gender groups".

This latter statement reflects what Eliot found in her review: as far as nature goes, boys and girls seem much more heterogeneous within their class than between; but socialization dramatically draws the genders apart in the USA. Girls tend to underperform if their social identity as girls is stressed [2, 4, 18]. It would seem that this is much less so in Sweden. Because girls and boys mixed there, they learned that girls and boys are in most respects not categorically different, but similar with overlapping variation. They learned to see one another as 'children' instead of 'boys' or 'girls'.

Finally, in a cross-cultural study among six-year olds, Martínez-Lozano et al. [23] found that Dutch children in a dyad were more likely to leave after a conflict if they did not get their way, whereas Spanish children were more likely to submit to the demands of their playmate. This could reflect a difference in power distance, larger in Spain, and/or in individualism, stronger in the Netherlands.

4 Agent-Based Model Design: The Boy-Girl Version

4.1 Representing Status-Power Theory in Child Behaviour

Status. Children are driven to confer and receive appropriate status: more is better, receiving too little status evokes the urge to use power in retaliation. The agents all start at status = 0.5 and converge on a dynamic status distribution that may or may not show a gender status gap (GSG; see Fig. 1).

Individual characteristics. Agents have a tendency to confer status, which we called their kindness in our model. They have a tendency to be found worthy of status conferrals, which we called their beauty, which might also be thought of as attractiveness or charisma. They have a capacity to use power *sensu* Kemper called their power. Power maximizes potential rough-and-tumble. All of the agent attributes are normally distributed on a 0..1 scale, and we can vary their means separately for boys and girls. They are depicted in the interface: smile for beauty, big eyes for kindness, power as the leftmost number, status as size.

Dyadic relationship. Each agent maintains a directed friendship indicator towards each of the others. This takes the form of a vector called *has-been-nice* of all agents with which it has played, in which it stores the memory of whether the other agent conferred adequate status. At each interaction, the existing value of has-been-nice is discounted against the new value depending on the parameter status-volatility. Thus, both agents in a dyad have a has-been-nice for one another that need not be symmetric. We can vary the update rate of girls and boys separately.

Reference groups: social identity. The model has two agent groups: boys and girls. A switch sex-factor-on-conferral (SFoC) decides whether boys and girls act in a gender-aware manner. If it is on, boys and girls will subtract the SFoC from their conferrals to children of the other sex. The SFoC thus acts as a social identity-related modification of status conferrals that is updated on each tick.

Power exchange. The three kinds of aggression found in the literature are distinguished. Physical aggression is modelled in two ways. First, rough-and-tumble bonus parts of status conferrals may be disregarded by the recipient but never by the sender, so that the two may disagree about how much status was conferred. Second, and more seriously, there can be open power exchange in fights. A fight benefits the stronger child's status, unless it is blamed by the group, in which the attacker loses status.

Relational aggression in our simulation can also be modelled as fights. Besides it can occur if a child stays away from another one based on their mutual history (negative 'has-been-nice'). Lack of prosociality is modelled simply as a low kindness level.

Rough-and-tumble. The fact that R&T usually happens between friends and is enjoyable has led us to model it as an aspect of status conferral rather than as power move. Humphreys and Smith [16] (p. 208) have a nice way of putting it:

"This suggests that a rough-and-tumble initiation was more in the nature of an invitation to which the recipient was free to respond in any manner or not at all than a challenge which had either to be met or refused".

4.2 Representing Nurture Through Culture

Four of Hofstede's dimensions of culture are operational in the simulation. They are used for system-wide parameters ranging from 0 to 100 that symbolize the social

environment internalized by the agents. The dimension scores were taken from [13]. This approach was shown to be feasible by Hofstede et al. [12].

Individualism. IDV moderates the likelihood that a child will leave a group when unhappy with the conferral it received, or the fight it was subjected to.

Power distance. PDI determines the likelihood that a child will pick a fight or leave a group, depending on its status. Low-status agents in large-power-distance cultures will be subdued and less likely to leave the group or pick a fight.

Masculinity. MAS moderates the likelihood of fighting (depending on the agent's power) and of conferring status rewards or penalties to fighters based on reference group ideals.

Uncertainty avoidance. Large UAI increases the likelihood that a group will blame a child for picking a fight against a child of the opposite sex.

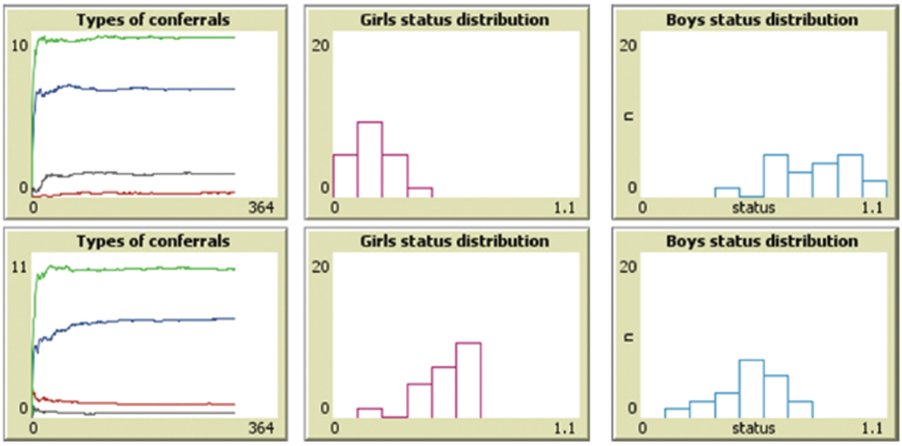

Fig. 1. Conferrals and resulting status distribution after 301 ticks for the same school class of 20 boys and 20 girls under different parameters. Left: conferrals per tick; green = happy, blue = mildly unhappy, black = fight condoned by group; red = fight blamed by group. Top row: MAS = 100, SFoCn;resulting GSG = 0.6. All boys dominate all girls. Bottom row: MAS = 0, SFoC off; resulting GSG = 0. No trace of a glass celling (Color figure online).

Cultural masculinity and social identity. Rough-and-tumble and fighting are subject to norms of praise or blame from the reference group, depending on the ideal. In a culture with MAS = 0, fighting is usually blamed, and this probability goes down when MAS goes up according to the formula:

```
to-report attacker-blamed-by-group?
report (random-float 1 > 1 – affront – 0.5 * sex-gap? * segregation-tendency –
                                0.5 * (1 – MAS / 100) +
                                ([status] of receiver – [status] of giver) * PDI / 100)
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In which

- Affront = status deficit perceived by receiver.
- Segregation-tendency = (((100-IDV) + UAI)/200).

4.3 Dynamics

The playground is an undifferentiated square. Children are randomly introduced at the outset, with equal status of 0.5, and then play during a run of a variable number of ticks. A tick represents something akin to a few seconds, enough to have a status exchange. 300 ticks would constitute a school break (Fig. 1).

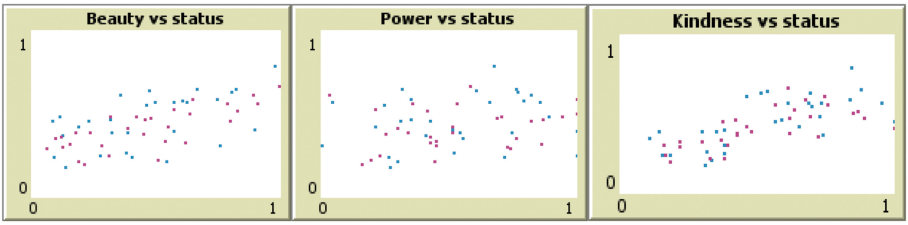

Fig. 2. Agent parameters (horizontal) vs status (vertical), after 301 ticks in a culture with MAS = 0. Status has become correlated with beauty and kindness.

Finding playmates. In each tick, each child that is alone looks for a child to play with. If it finds one it becomes 'attracted', which is a status claim. If the potential playmate accepts the claim and is 'attracted' back, they will join. If the playmate was alone, the two of them form a new group. If the playmate is already in a group, the first child joins that child's group, adopting its reference group's status bookkeeping.

Status exchange: conferral. Once in a group the child selects a group member at random to exchange status with, assuming that in a group, all children are playing together even if some might be more attractive than others. A status exchange involves a status conferral by the giver and an interpretation by the receiver. The conferral may include a rough-and-tumble action.

Status exchange: interpretation. If the receiver interprets the conferral as insufficient, that is, as lower than its current status in the reference group in action, then the receiver may, depending on the perceived status deficit ('perceived-affront') decide to pick a fight. Willingness-to-fight is dependent on culture.

Power exchange. In case of a fight, power of the two fighters becomes important in determining the outcome, along with perceived-affront. The winner gains status whereas the loser loses an equal amount.

Leaving a group. After a fight, one or both fighters may decide to leave the group. An agent could also leave if it was unsatisfied with a conferral it received but did not actually fight.

5 Model Results

The boy-girl version was tested with 20 runs per condition on classes of 30 girls and 30 boys. Figure 1 shows plots of univariate analysis of variance with gender-status-gap as the dependent variable.

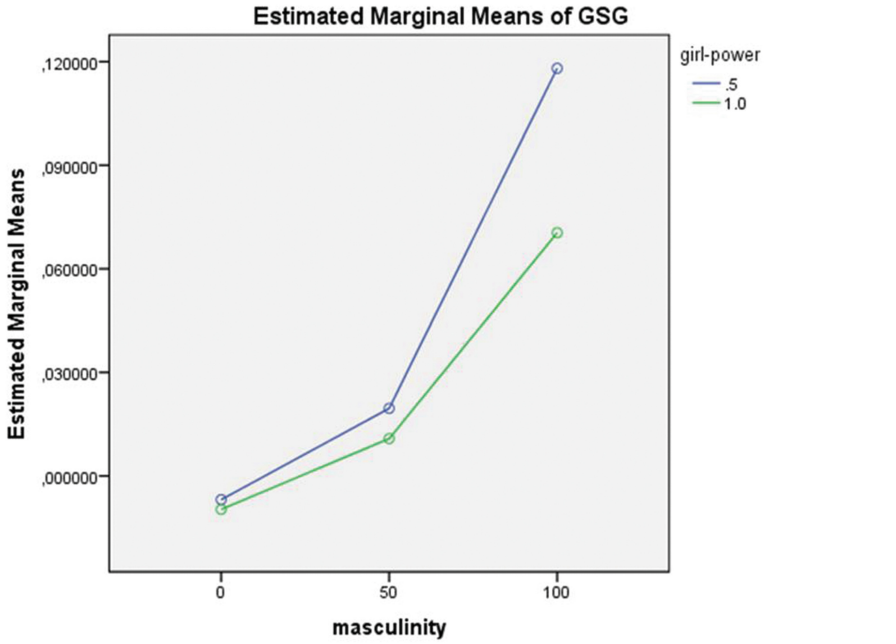

Fig. 3. ANOVA of gender-status-gap (GSG) against MAS and girl-power. No rough-and-tumble.

Hypothesis 1. "Social status does correlate with kindness in feminine cultures" is confirmed by Fig. 2. The figure averages runs with girl-kindness = 1 and girl-kindness = 1.5 (girls kinder than boys). Under MAS = 0 the GSG is negative, meaning boys have lower average status than girls. This is the case even if boys are stronger (girl-power = 0.5) (Fig. 3).

Hypothesis 2. "Social status will correlate with power in masculine cultures", is also confirmed. As MAS goes up, the GSG favours boys more, and the effect of differences in power is amplified.

Hypothesis 3. "Rough-and-tumble will boost social status" is not shown in a figure for lack of space. The same runs as in Fig. 1 but with R&T turned on yield higher GSG in all conditions, the difference increasing from 0.01 at MAS = 0 and girl-power = 1–0.55 at MAS = 100 and girl-power = 0.5.

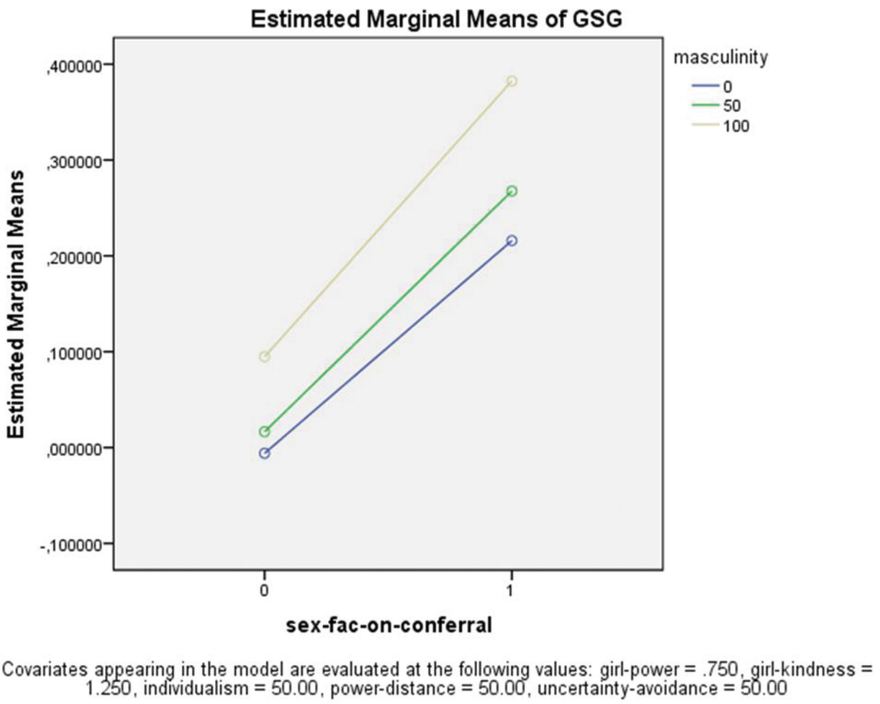

Fig. 4. Gender-status-gap (GSG) against sex-factor-on-conferral (SFoC) & MAS.

Hypothesis 4. "Categorical differences in status accord based on gender will enlarge any tendency to gender-based status differentiation" receives overwhelming support, to the extent that it can precipitate full glass ceiling phenomena in which no girls achieve high status. Switching SFoC on can lead to gender status gaps of .2 under MAS = 0, until .4 under MAS = 100 (Fig. 4).

6 Discussion

The playground simulation operationalizes 'nature' as possible differences in power between boys and girls, in tendency to perform power-related behaviours (rough-and-tumble and fighting), as well as in relationship updating. The effects of even large variations of these are modest.

The simulation operationalizes 'nurture' as culture parameters in combination with variable social identity. The combined effect is pervasive, since it strongly modifies the social reward to engage in the power-related practices. This combined effect materializes through self-organization of boys and girls. As such the model seems a promising way to study self-organization in all kinds of social settings, such as organizations, schools, and social life in general.

The results suggest that reference group dynamics are by far the most powerful causal factor for the establishment of glass-ceiling like phenomena. If girls receive less status just because they are girls, this has huge emergent effects. And they do, as illustrated by the case of little Toby with which this article began. Our social identity model version is a promising tool for future development.

The second most powerful factor in the simulation is culture, in this case a masculine value system that supports the use of power in the pursuit of status.

Nature, in the form of differences in 'in-born' kindness and power between the sexes, plays a modest role in itself. This role can be very strongly amplified by culture and by reference group logic, through emergent results of interaction.

One more remark can be made pertaining to gender roles. In feminine societies in our model, fighting is blameable. This leads to flatter status hierarchies, but not necessarily to gender equality, since any occurring gender gap will go uncontested. Masculine societies lead to larger gender gaps but with some strong girls fighting themselves to the top. This confirms [11] on macaques and [13] on humans.

Methodological remarks can also be made. This study operationalizes three major social scientific theories and a body of experimental work on development psychology. The integration of these three is new and tentative. The resulting model is a hypothesis-generating engine; it begs more questions than it answers. Here are some important questions for further investigation.

- How to model this system with actual reference groups, in which every child may have a different social status in every reference group? We have a version of a simulation that does this, but at the time of writing the results are too tentative to say much about them.
- How to integrate praiseworthiness or blameworthiness of fighting better with social identity theory? For instance, at present there is no concept of 'fair fighting', that is, refraining from fighting weak opponents, or children of the other sex.
- How to articulate the dynamics of membership of a group or category versus commitment to it?
- How do agents maintain their 'status landscape' across reference groups? This involves which groups to commit to and spend time in, and how to transfer status information between reference groups. The dynamics of commitment to reference groups are likely to be nontrivial.
- What are the system-level consequences of the previous point, i.e. how are statuses ranked between reference groups? Status and power relationships between reference groups might be called prejudices, prototypes, or ideal types.
- In connection with the previous one, what if a conferral to one member of a reference group is interpreted as a conferral to the identity of that group?
- To what extent can we re-use this model for other purposes, e.g. the social reality of the financial world?
- How far can these particular theories take our models? On what grounds should we change or supplement them?

7 Conclusion

The model introduced here confirms the importance of emergent patterns of behaviour in modifying differences due to both nature and nurture. Social identity issues seem more pervasive in bringing the effects of influences from both nature and nurture about. In the lives of children, nurture amplifies nature through self-organisation.

On a meta-level, the model convincingly shows that it is worthwhile to put social scientific theory in the centre of agent-based models that investigate theoretical points. This enables to both create convincing models and scrutinize the theories used.

This work is only the first step in what could be a rich area for further study of various areas of social reality, not just children's lives.

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