

The Social Impact of Self-Regulation on the Evolution of Simple and Complex Creative Ideas

Computational Creativity 2014

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Outline



- ✦ Introduction
- ✦ EVOC: A Computer Model of the Evolution of Creative Ideas
- ✦ Incorporation of Social Regulation of Creativity
- ✦ Results
- ✦ Conclusions

Honing Theory of Creativity



- ✦ Rooted in evolutionary theory:
 - ✦ Minds (not memes) as self-organizing autopoietic structures that evolve through culture
- ✦ Creative process involves, not search or selection amongst well-formed candidate ideas, but *actualizing potential of ill-formed candidate by considering it from new perspectives*
- ✦ Insight as self-organized criticality
- ✦ Emphasis on *transformative process* (as opposed to external product); *creating feels good*
- ✦ Creative process is **minds self-organize** in response to perturbation / inconsistency to achieve stable, adaptive state – *at level of society as well as individual*

Social Self-organization of Creativity



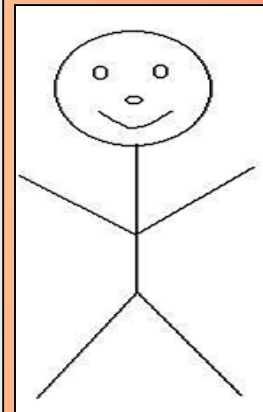
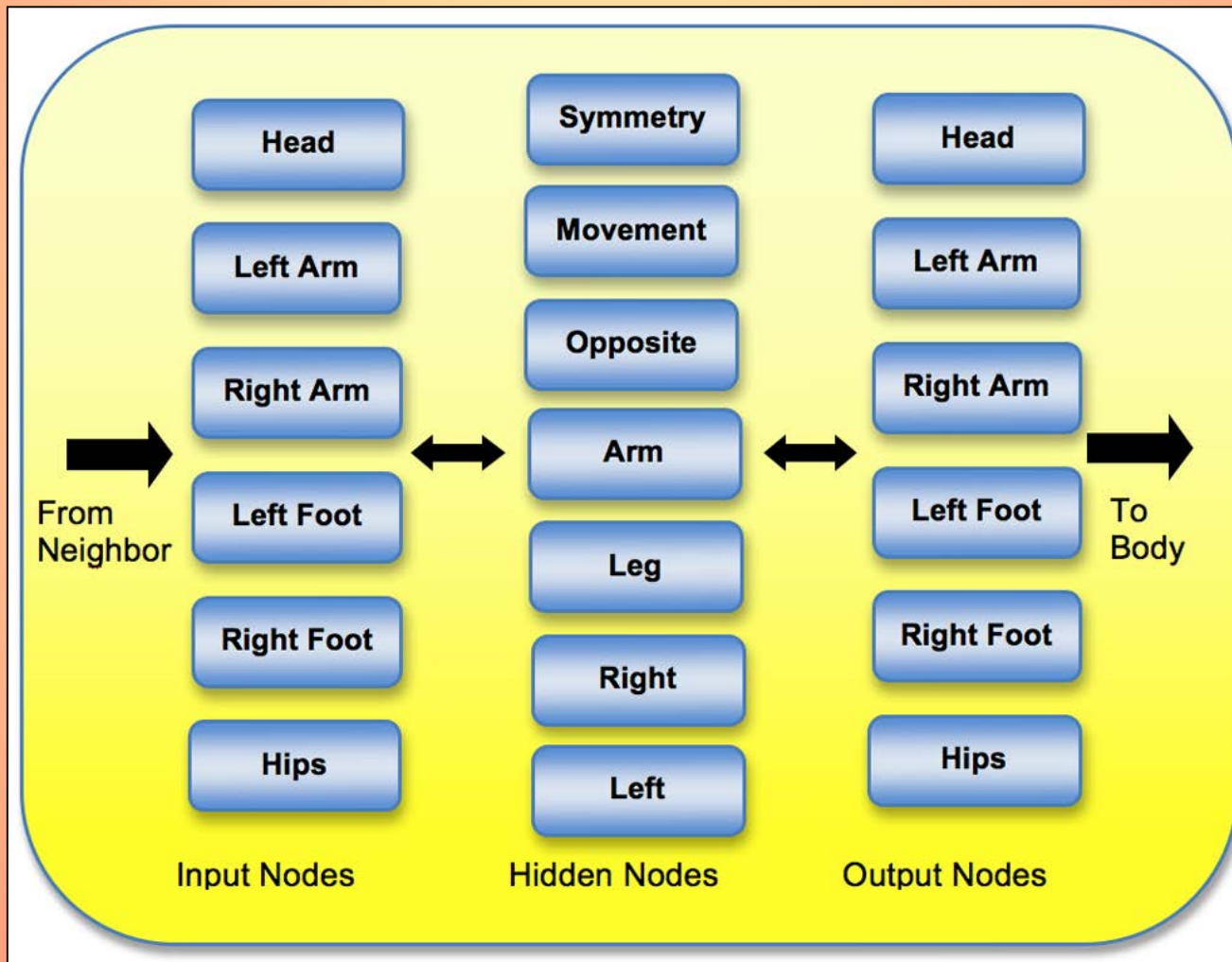
- ✦ Creative behavior is time consuming, often redundant, and correlated with proneness to affective disorders and substance abuse (Andreason, 1987; Cropley, Cropley, Kaufman, & Runco, 2010; Jamieson, 1993; Ludwig, 1995)
- ✦ Many individuals benefit from creativity without being creative themselves by imitating creators
- ✦ But if *everyone* adopts this strategy, society suffers
- ✦ Used computational model of cultural evolution to see if there would be reason to expect self-organizing forces modulating degree of creativity at societal level (Gabora, Chia & Firouzi, 2013; Gabora & Firouzi, 2012; Gabora & Leijnen, 2009)

EVOLution of Culture (EVOc): A Computational Model

(Gabora, 1995, 2008a,b; Gabora & Firouzi, 2012; Gabora & Saberi, 2011; Leijnen & Gabora, 2009a,b, 2010)

- ✦ Artificial society of neural network based agents that invent and imitate ideas for actions
- ✦ Actions confer varying degrees of fitness or value for agent
- ✦ Fitness of gesture reflects amount and direction of movement at each body part
- ✦ Original fitness function: 729 possible single-step actions, 8 of which are optimal
- ✦ Other fitness functions have been developed which allow potentially infinite variety of multi-step actions
- ✦ Explicitly based on communal exchange based non-Darwinian model of cultural evolution: no sequestered self-assembly code; transmission of acquired traits; non-random variation

Artificial Agents



An Iteration

- ✦ Each agent can either
 - ✦ **Invent:** Create new action
 - ✦ Probabilistically modify direction/degree of motion at one (or more) body part
 - ✦ Biased by learned generalizations re how symmetry and degree of movement affect fitness
 - ✦ **Imitate:** Copy action performed by neighbor
 - ✦ Only imitates if fitness of neighbor's action is greater than fitness of its own current action
- ✦ Can vary parameters such as
 - ✦ Ratio of creators to imitators (C)
 - ✦ How creative the creators are (p)
 - ✦ Whether multi-step actions are possible
 - ✦ ...

Outline of Typical Run

- ✦ Initially all agents are immobile, implementing 'do nothing' idea, which has low fitness
- ✦ Some agent invents some action
- ✦ It has higher fitness than 'do nothing', so gets imitated
- ✦ As agents continue to invent new actions and imitate neighbors whose actions are fitter than their own, the mean fitness of actions increases
- ✦ Diversity of actions increases as space of possible actions is explored, then decreases as agents converge on fit actions

Agent Control Panel

Invention to Imitation Ratio = 1:1

0 1 2 3 4 5 6 7 8 9 10

Rate of Conceptual Change: 0.17

0 10 20 30 40 50 60 70 80 90 100

Enter number of Agents (25, 64, 100 or 1600)

64

Create and Populate Model World

Enter number of Iterations

5,100

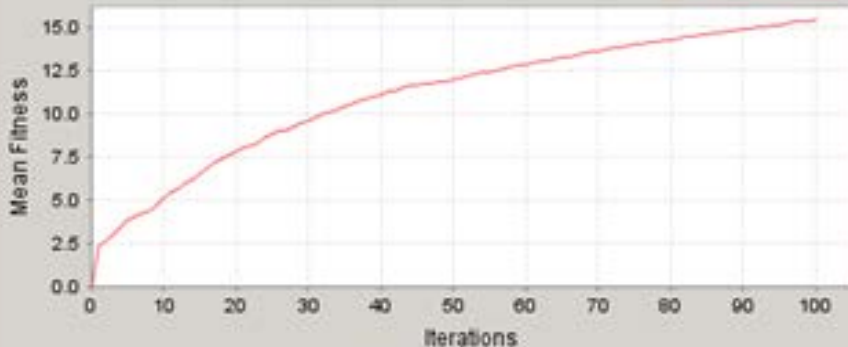
Begin

The Model World

0,0	0,1	0,2	0,3	0,4	0,5	0,6	0,7
1,0	1,1	1,2	1,3	1,4	1,5	1,6	1,7
2,0	2,1	2,2	2,3	2,4	2,5	2,6	2,7
3,0	3,1	3,2	3,3	3,4	3,5	3,6	3,7
4,0	4,1	4,2	4,3	4,4	4,5	4,6	4,7
5,0	5,1	5,2	5,3	5,4	5,5	5,6	5,7
6,0	6,1	6,2	6,3	6,4	6,5	6,6	6,7
7,0	7,1	7,2	7,3	7,4	7,5	7,6	7,7

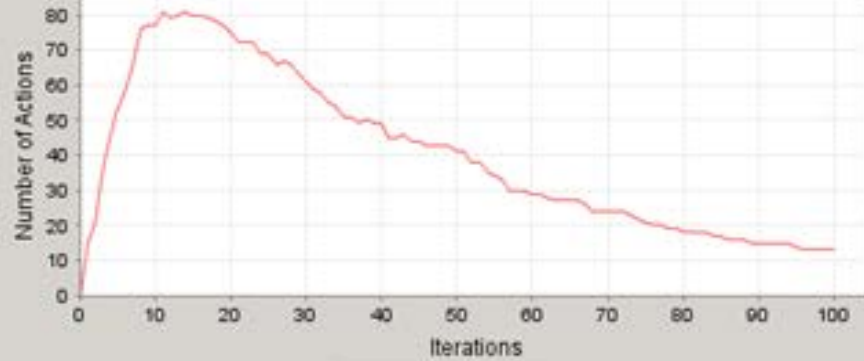
Graphs of this Trial

MEAN FITNESS OF ACTIONS



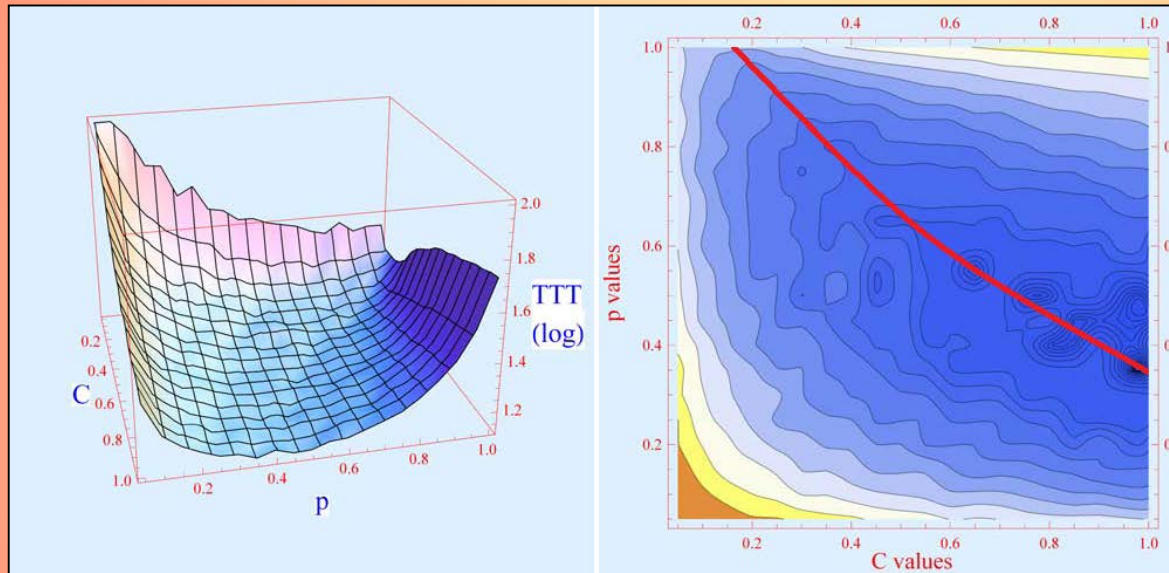
Complete run 16

ACTION DIVERSITY



Complete run 16

Tradeoff between Proportion of Creators and How Creative They Should be



Time-to-Threshold Discounting measures how many iterations for fitness to reach threshold τ . In these graphs, $\tau = 9$.

3D graph (left) and contour plot (right) showing \log_{10} Time-to-Threshold (TTT) landscape of average mean fitness for different values of C (proportion of creators) and p (how creative they are). Red line in contour plot shows a clear ridge in fitness landscape. This indicates that there are optimal values of C and p that are sub-maximal for most $\{C, p\}$ settings.

No matter how you analyze data, same result:

The more creators there are, the less creative they should be.

Incorporating Social Regulation

- ✦ Where, $p(C)_n$ is probability a particular agent invents in iteration n , and RF is its relative fitness of outputs:

$$p(C)_n = \begin{cases} 1, & \text{if } p(C)_{n-1} \times RF_{n-1} > 1 \\ p(C)_{n-1} \times RF_{n-1}, & \text{otherwise} \end{cases}$$

- ✦ If value of a particular agents' outputs was greater than societal mean, probability of inventing increased
- ✦ If value of agents' creative outputs was less than societal mean, probability of inventing decreased
- ✦ This kind of self-regulation could occur in response to either personal satisfaction or dissatisfaction with creative outputs, social feedback, but social feedback was not explicitly incorporated in the model

Segregation into Inventors and Imitators

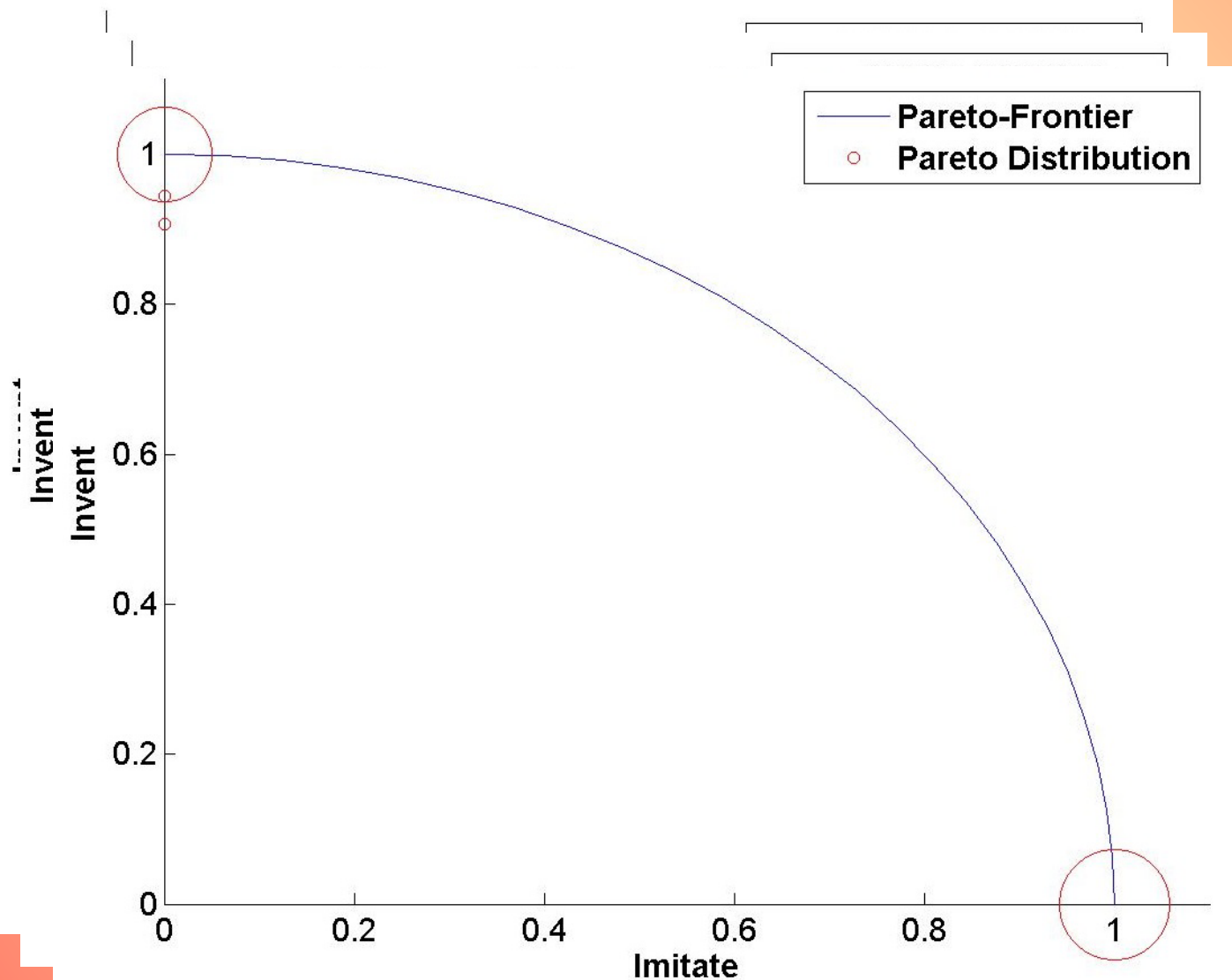


Fig 3a: In iterations 1 to 10, fitness of actions was low whether they arose through invention or imitation.
Fig 3b: By iterations 25 to 35 some agents do better as inventors and other do better as imitators.
Fig 3c: By iterations 90 to 100 they reached the pareto frontier and segregated into two distinctive groups: inventors and imitators.

Social Regulation Increases Value and Diversity of Outputs

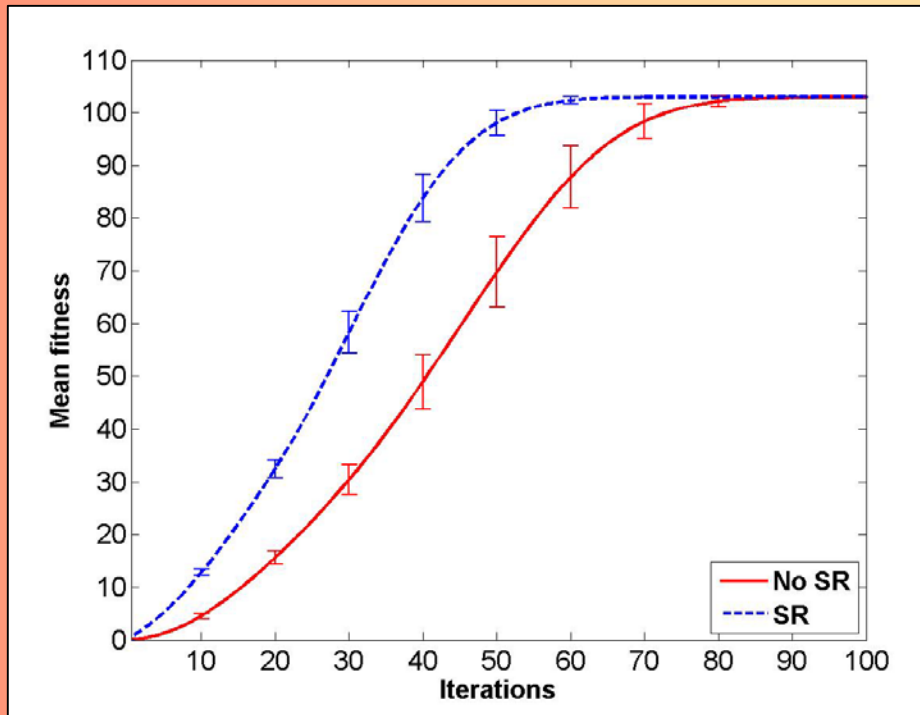


Fig 1: Mean fitness of outputs across all agents increases with social regulation.

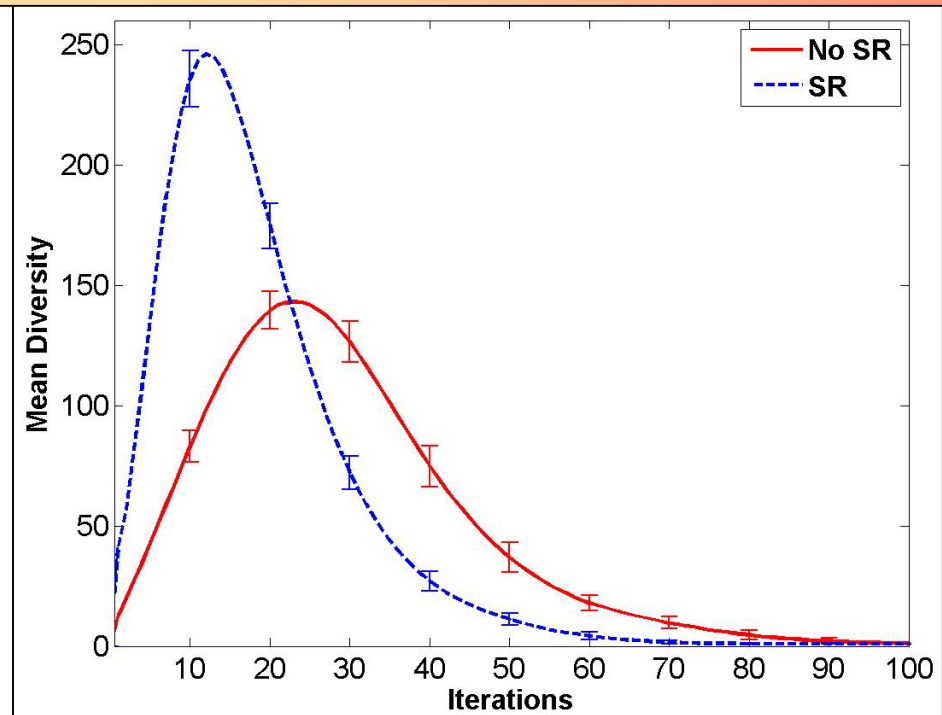


Fig 2: Diversity of outputs across all agents increases with social regulation.

Incorporation of Chaining

- ✦ In long run performing as well without SR as with it
- ✦ Hypothesized that this was artifact of finite space of possible actions; eventually all converge on optimal actions no matter what
- ✦ Investigated what would happen if space of possible actions was open-ended
- ✦ Agents could chain single-step actions into infinite variety of multi-step actions

FI^* = The version of fitness function FI that allows for chained actions.

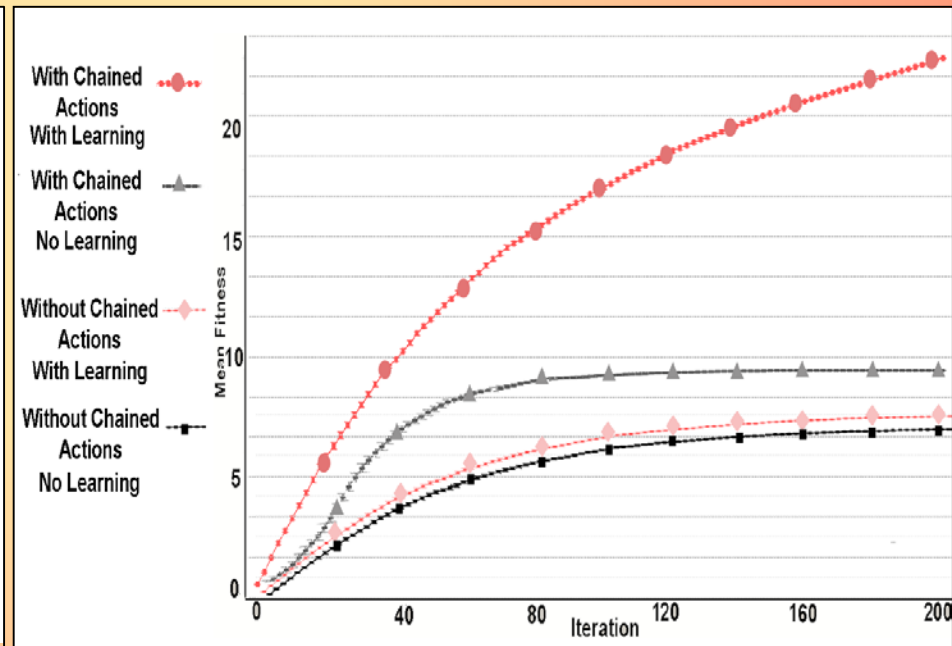
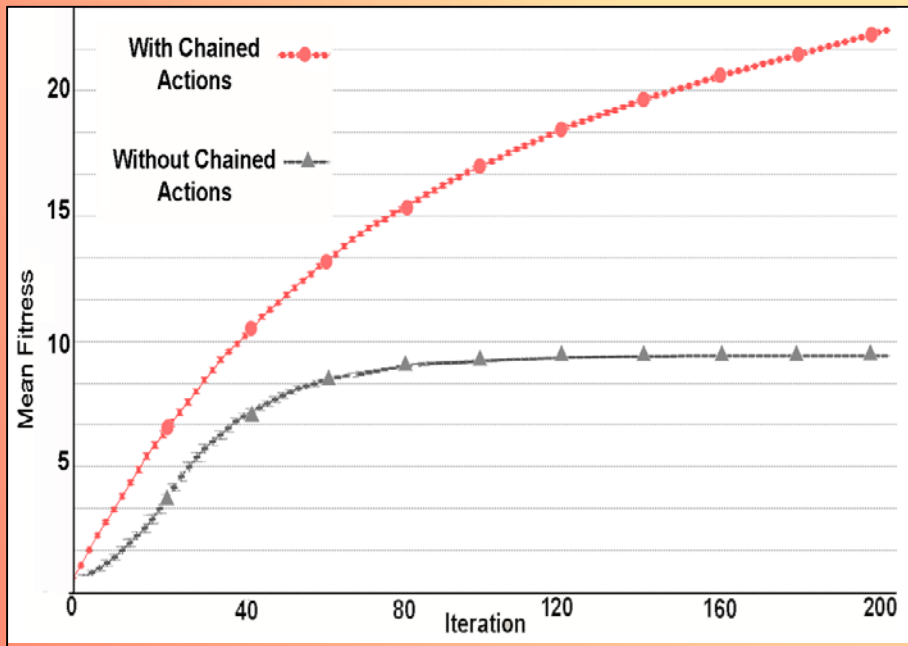
$aLA_{n(i)}$ = Activation of LEFT ARM output node at step i of iteration n

$FI^*_{n(i)}(X)$ = Action fitness at step i of iteration n for agent X

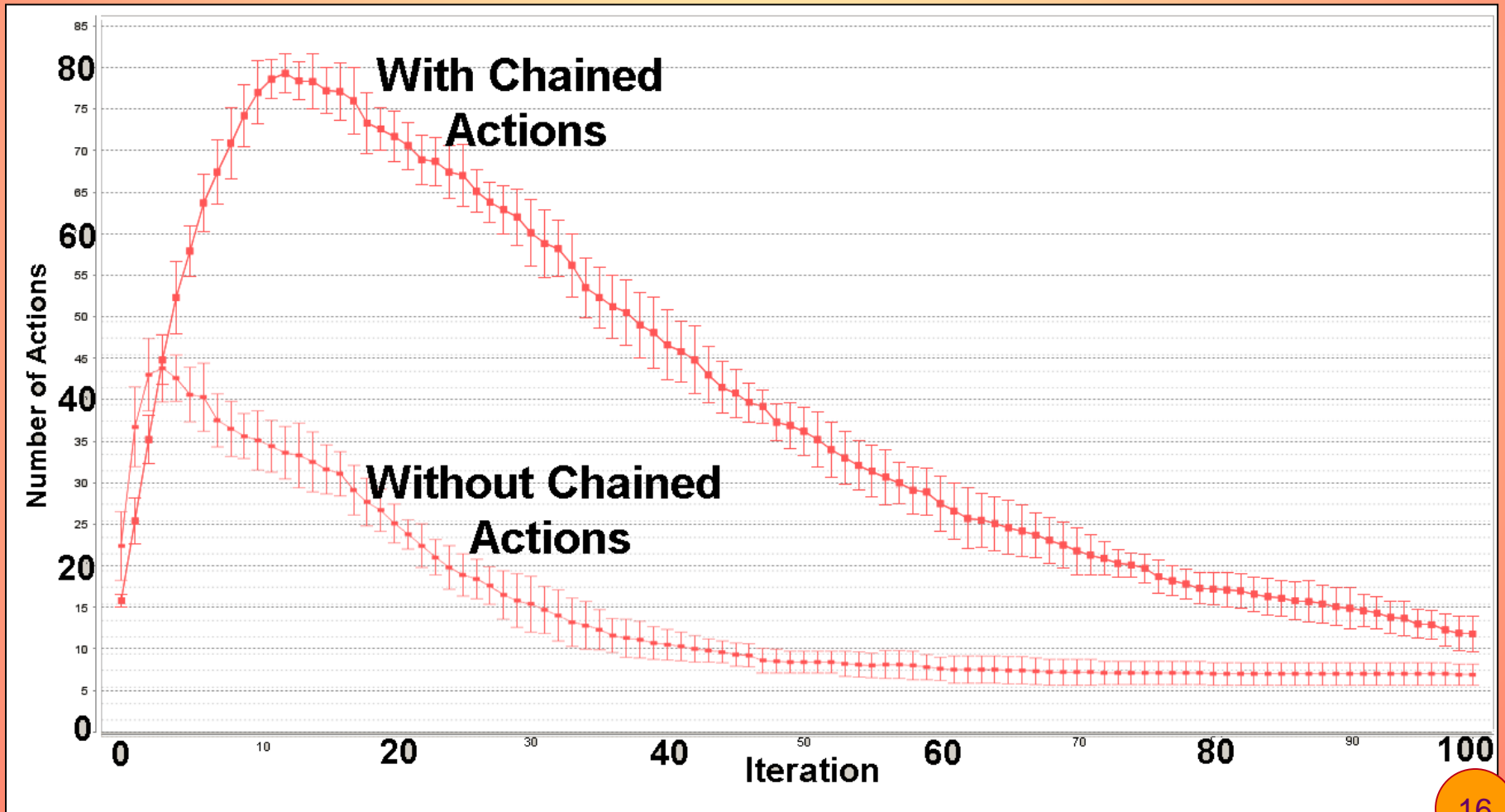
While $aLA_{n(i+1)}$ is in the opposite direction of $aLA_{n(i)}$

$$FI^*_{n(i+1)}(X) = FI^*_{n(i)}(X) + 1$$

Previous Results: Chaining Enables Open-ended Cumulative Change and Magnifies Effectiveness of Ability to Learn Trends



Previous Results 2: Chaining Increases Diversity of Actions across Society



Chaining Makes Effect of Social Regulation on Value and Diversity of Outputs Sustainable

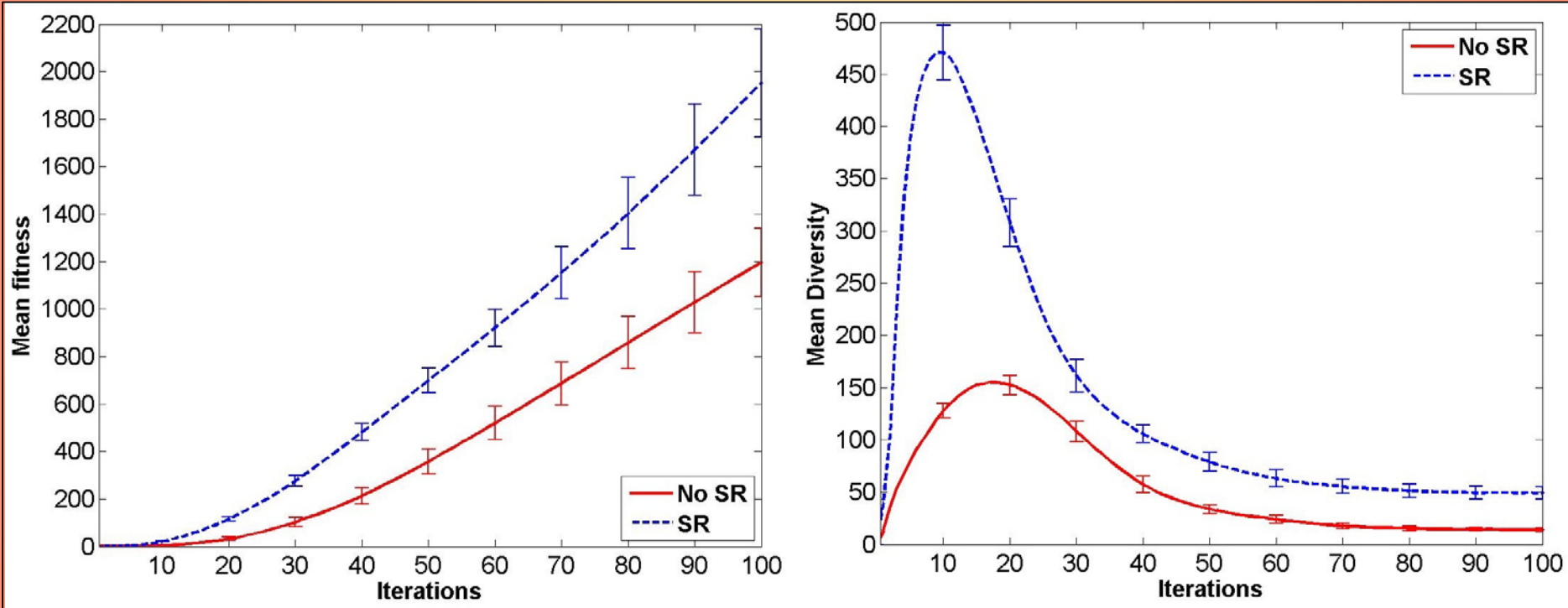


Fig 4: Mean fitness and diversity of outputs across all agents over the duration of the run with chaining, with and without social regulation. Again, social regulation increases fitness and diversity, but now it is possible to invent an open-ended array of increasingly fit outputs.

Conclusions



- ✦ Incorporating SR – such that successful creators create more and unsuccessful creators create less – increased fitness and diversity of creative outputs
- ✦ Balances novelty-generating effects of invention and novelty-retaining effects of imitation – both of which are necessary for cultural evolution
- ✦ Suggests possible adaptive value to Florida's (2002) controversial notion of a "creative class"
- ✦ Benefits of SR short-lived unless creativity incorporates chaining of simple outputs into complex ones
- ✦ Suggests social regulation / self-monitoring evolved hand-in-hand with capacity for chaining

Future Work



- ✦ Incorporate more psychologically realistic creative process
- ✦ Findings imply that societies may propel children along two different developmental trajectories depending on early indications of creative potential
- ✦ There is some evidence that girls are socialized in ways that discourage creative development
- ✦ Examining implications for social factors that promote or discourage developmental differences in creativity between boys and girls

Thank You!

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For more information:

<https://www.ubc.ca/ok/people/lgabora>



Social Sciences and Humanities
Research Council of Canada

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Canada





From theory to practice... FaceCo



The opening screen prompts the user to indicate whether they want to generate new face fry or work with a previously saved one.



Next screen prompts user to indicate whether they want to make a fry of a single face or mate two faces together.



A face found in photo is indicated by a green box. User is prompted to tap green box of face they want a fry made of.



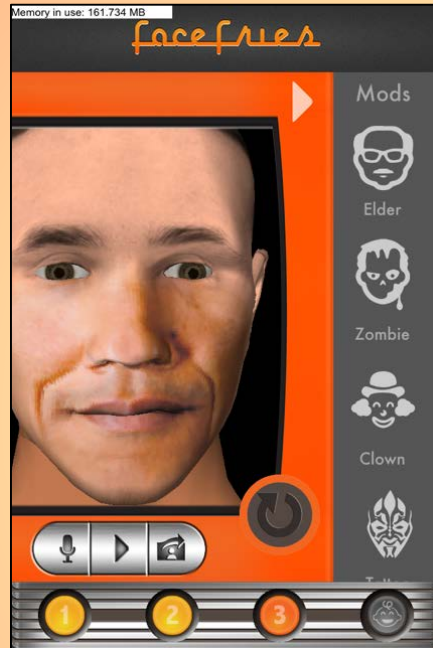
The user taps the next screen to select a photo, either from photo album or by taking a new photo using the camera.

face fries

by FaceCo



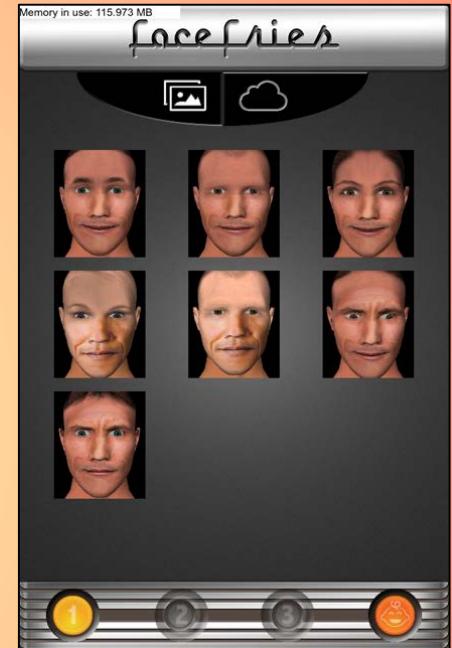
Once the user selects a face, a miniature 3D representation of the face appears, and the user is prompted to hit 'GO' to generate the face fry.



Now we have an animated, talking 3D face fry! Hitting microphone records what you say so the fry can say it back. Sliding control panel to left reveals mod options.



Sliding control panel to the right reveals saving and sharing options. (Current set of mods is shown on next page.)



Tapping "gallery" reveals the user's previously saved face fries. Tapping cloud reveals face fries that others have given user access to on cloud (not shown).

face fries

by FaceCo



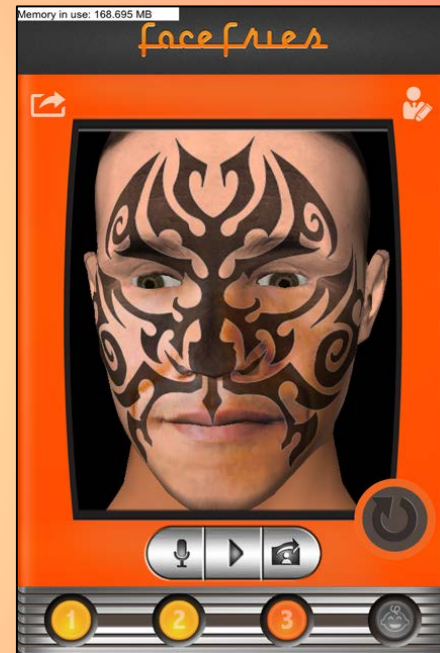
Elder



Zombie



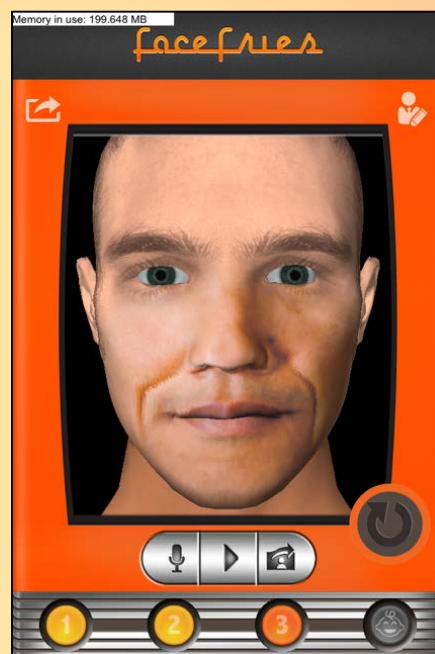
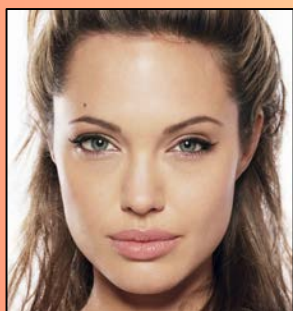
Clown



Tattoo

face fries

by FaceCo



Input photographs of Barack Obama and Angelina Joli.

Face fries of Angelina Joli and Barack Obama. It gets sex right 90% of time.

A first (male) face fry 'offspring'.

A second (female) face fry 'offspring'.