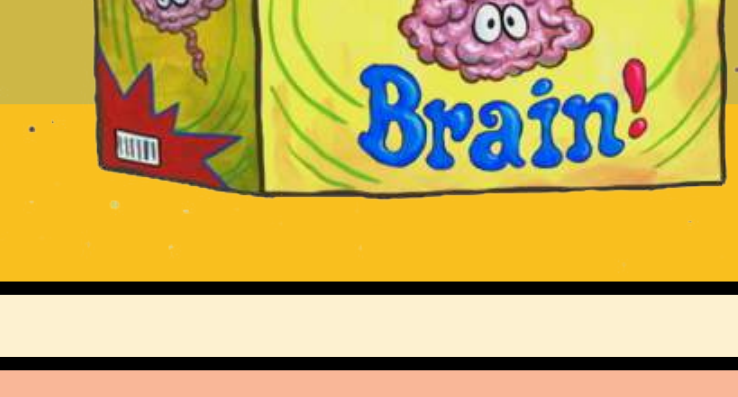


MOTIVATED CONTROL OF SOCIAL LEARNING STRATEGIES:

An Exploration into Opening the Black Box

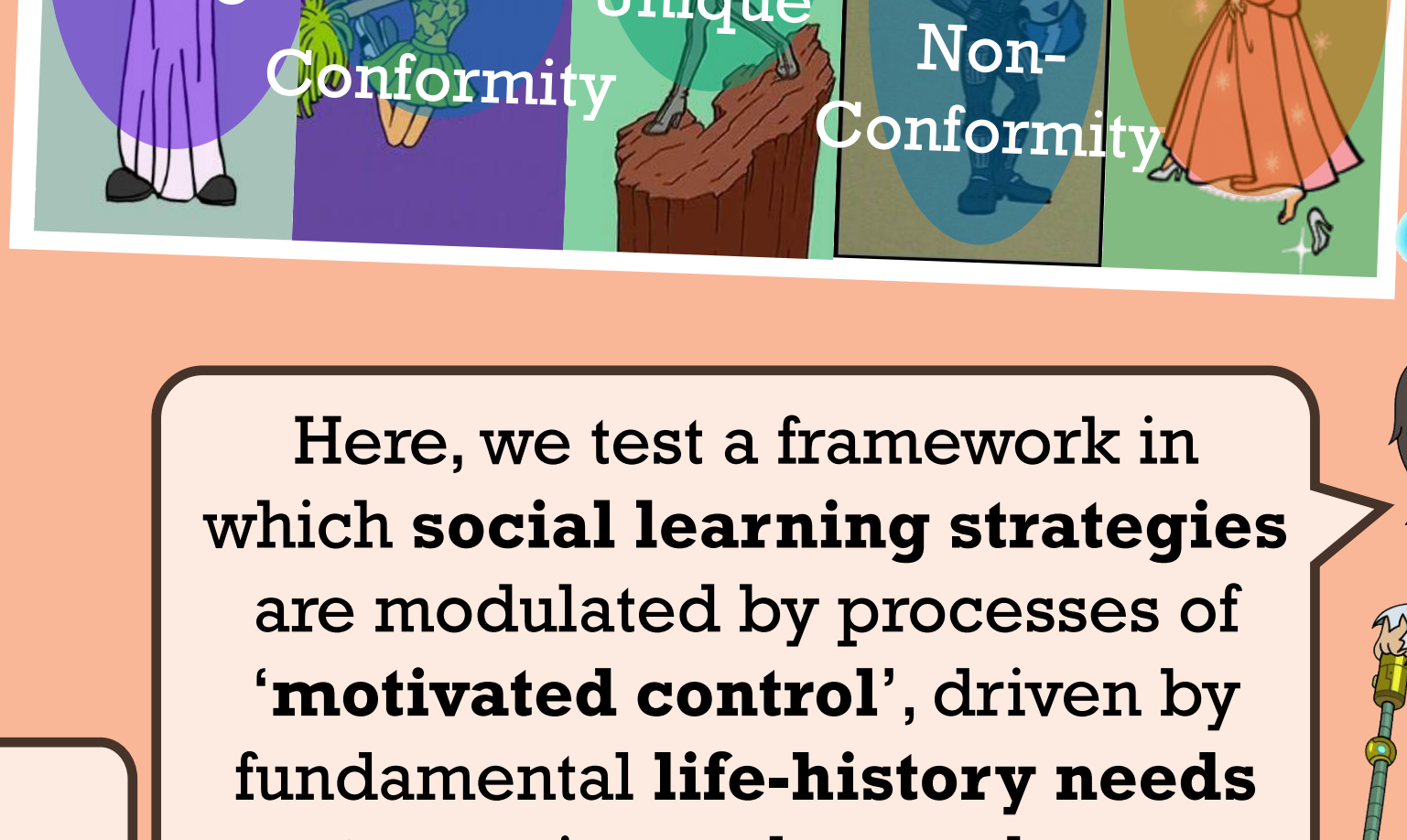
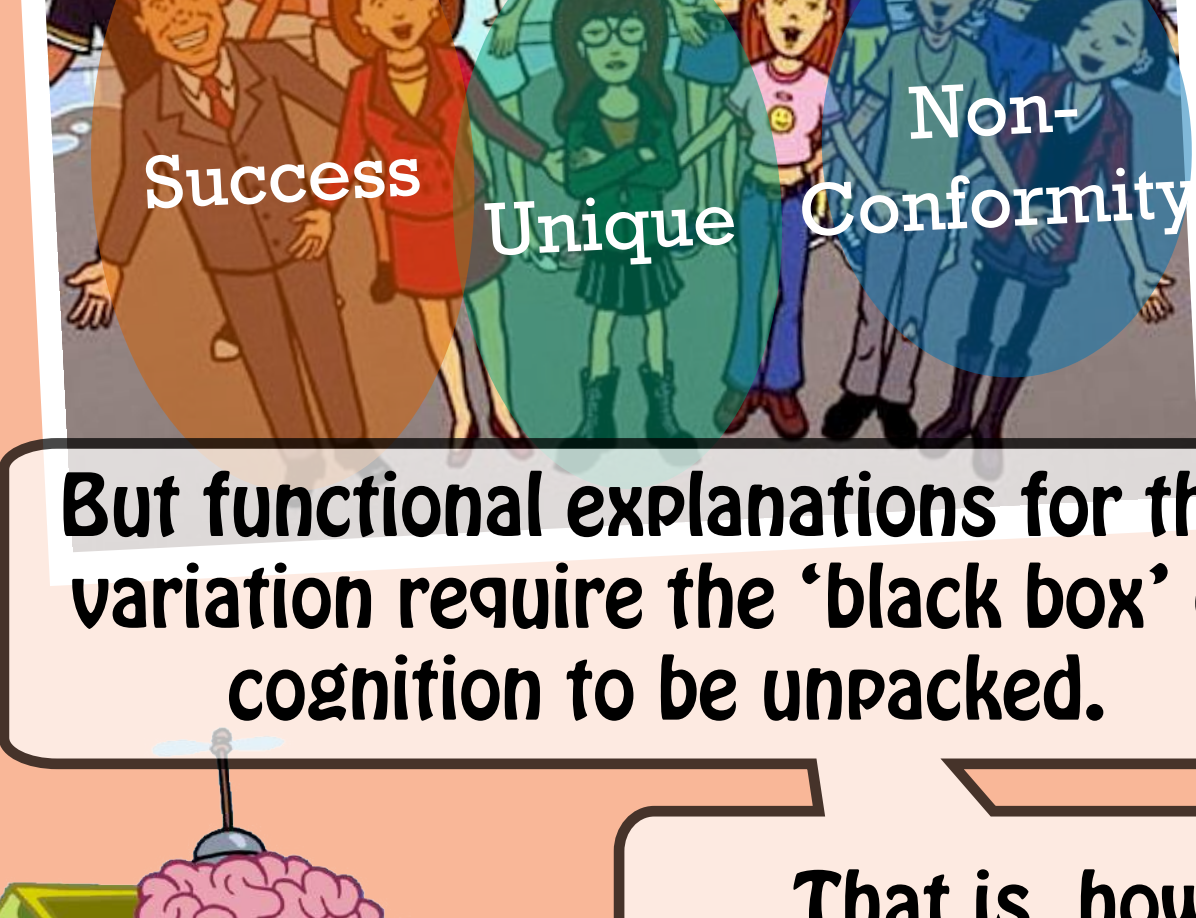
Stephen Heap, Mikael Puurtinen, Catharine Cross, Kevin Laland



Taking the Brain Out of the Box

Social learning strategies and biases can vary between different individuals...

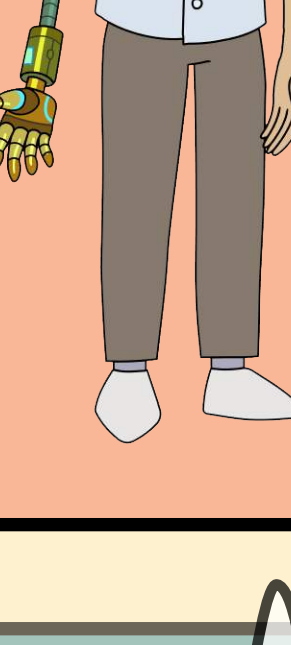
... and within the same individual.



But functional explanations for this variation require the 'black box' of cognition to be unpacked.

Here, we test a framework in which social learning strategies are modulated by processes of 'motivated control', driven by fundamental life-history needs to survive and reproduce.

That is, how do cognitive-behavioural mechanisms modulate social learning?



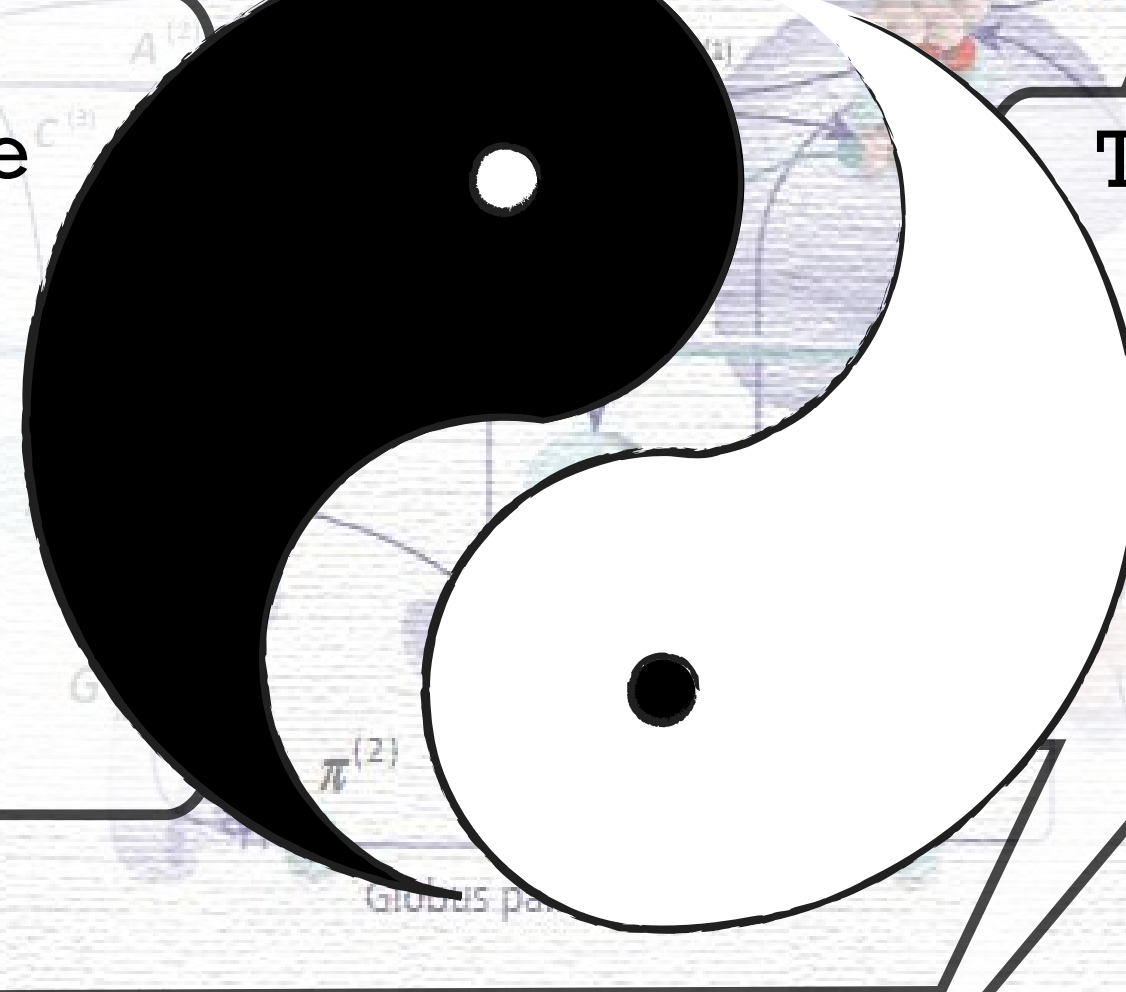
Heyes C. Blackboxing: Social learning strategies and cultural evolution. *Philos Trans R Soc B Biol Sci.* 2016;371(1693). doi:10.1098/rstb.2015.0369

Motivated Control

From drinking a glass of water to fulfilling a PhD, the brain must make predictions about future states and infer the appropriate sequence of actions or overarching strategies that can achieve its goals.

This may involve two distinct but integrated cognitive processes.

The **motivational** component is responsible for determining the likelihood of different outcomes given what's known, and ranking these outcomes by their desirability.



The **control** component develops the plan of action, whether it be a sequence of body movements or executive strategizing.

Behaviours are the outcome of the **functional integration** between these components as they coordinate and manage activity across different scales of space and time.

Pezzulo G, Rigoli F, Friston KJ. Hierarchical Active Inference: A Theory of Motivated Control. *Trends Cogn Sci.* 2018;22(4):294-306. doi:10.1016/j.tics.2018.01.009

Motivated Control & Social Learning Strategies

The **motivational component** carries deep-rooted expectations for the outcomes of social interactions. These expectations are inherited from genes, personal experience and culture.

These expectations are responsive to prevailing environmental cues. The 'cognitive calculus' of motivation changes its priorities depending on the current context and goals.

Social learning strategies can have implications for social contexts and goals.

Meanwhile, **social learning strategies** factor into the processes of the **control component** by their nature.

Thus, the consequences of **social learning strategies** factor into the cognitive calculus of the **motivational component**.

(Consider how sometimes it's wise to follow-the-majority because being different would violate norms)

Social learning strategies involve behavioural action plans of **motor control**.

These behavioural policies may also require coordinated change at scale, and involve **high-order processing**.

In humans, this extends to even higher orders of **metacognition**.

Social learning strategies may involve both an aspect of control (because they are a behavioural course of action), and an aspect of motivation (because they can have predictable fitness consequences).

Hypothesis!

If we vary social motivations, then social learning strategies will vary too.

'Fundamental Motivations' to Survive and Reproduce
For Example...

- Self-protection:** evade physical danger
- Disease-avoidance:** avoid infections
- Affiliation:** form and maintain cooperative alliances
- Status:** gain and maintain respect, prestige and power
- Mate-acquisition:** acquire a desirable partner
- Mate-retention:** foster long-term mating bond
- Kin care:** invest in family and offspring

Social Learning Strategies
For Example...

- Random copying**
- Copy the successful**
- Follow the majority**
- Copy digital natives**
- Do what no-one else is doing**
- Copy if uncertain**
- Copy family or kin**

Because life-history is a well studied game, we can derive clear predictions for the social learning strategies used in certain contexts.

We chose three contexts to investigate, since they had the clearest predictions for the social utility of different outcomes.

Mate-Acquisition

The demands of sexual selection favour the bold and those that stand out from the crowd.

Social learning strategies that avoid common solutions and approach the unique may be considered more beneficial when looking for love.

Disease-Avoidance

A good way to avoid getting sick is to stay clear of others.

Social learning strategies that socially distance could be the most beneficial when trying to stay safe.

Self-Protection

When people feel threatened by others they tend to adopt a 'selfish herd' mentality and seek safety in numbers.

Social learning strategies that conform with the majority and don't stand out keep one under the radar.

Measuring Bias

To bring participants into the right 'state of mind' for each context, we primed them with stimulating images and questions, and 'framed' the language of the task.

Participants were forced to rely on contextual cues. We obscured any information about the 'rules of the game' and provided no feedback.

Otherwise, the tasks, their solutions, and the presented social information remained constant. Therefore, any variation in behaviour could be attributed to variation in the priming and framing.

The social information provides four attractors of analytical interest.

Success: one response marked with red or yellow to signify it as being the response of the 'highest scoring participant'

Similarity: one response marked with red or yellow to signify it as belonging to the participant with the 'most similar answers' as the focal subject.

Positive-frequency: one response associated with three participants.

Negative-frequency (unique): one response conspicuously absent from the social information.

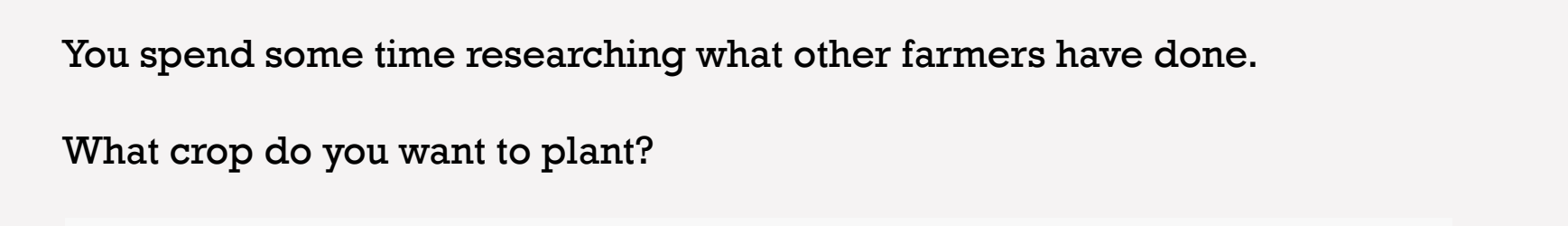
Example social learning tasks (from the non-social control)

1. In this task you must select a path through a grid. You can only select one cell for each row. Starting from the bottom of the grid, you must select at least three cells to create your path. The fourth cell, on the top, is optional. You will be provided with information on the path produced by 9 others.

Here are the paths chosen from the information pool.



Please select your path.

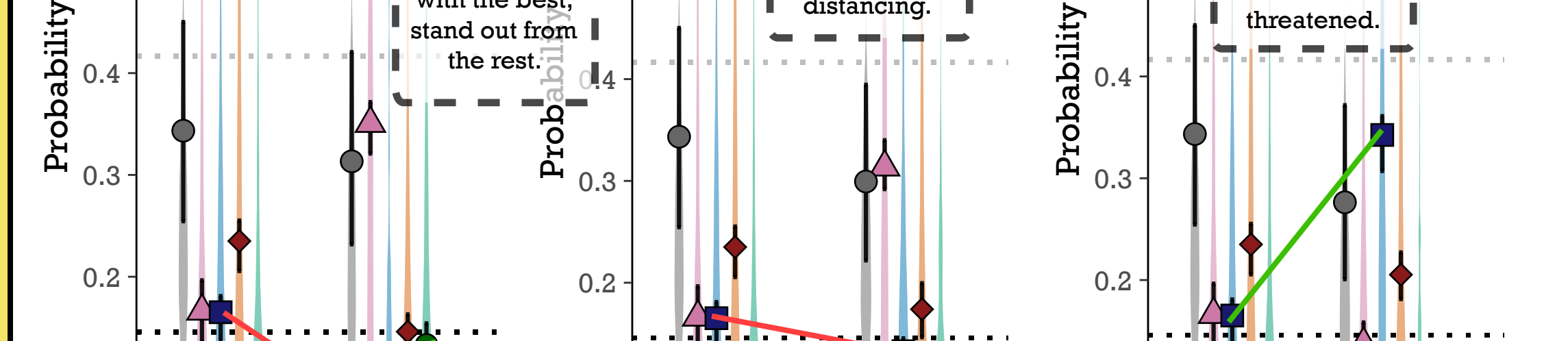


2. You have been tasked with managing a farm and have to choose one of six crops to plant. You spend some time researching what other farmers have done.

What crop do you want to plant?



Modulated by Motivation



We have clear support for our predictions in the **mate-acquisition context**. Subjects were around 65% less likely to follow the majority, and 36% more likely to utilize the unique response niche compared to the control.

Furthermore, unique solutions seemed to be avoided in all contexts except for mate-acquisition.

The situation was less clear in the **disease-avoidance context**. Here subjects were 24% less likely to use frequent solutions than the control, but the trend was not significant.

Our results are that the priming and framing devices were not effective.

We find strong support in the **self-protection context**. Subjects were twice as likely to follow-the-majority, and half as likely to go-it-alone compared to the control.

We also used a survey to range individuals across a range of dimensions. Including this information offered no better explanation for variation in biases than context alone.

So What?

This evidence supports our hypothesis. Social learning strategies were responsive to cues associated with fundamental motivational interests.

That being said, there are two major implications for this framework. The psychological processes of social learning may at least partly be mediated by cognitive systems of motivated control.

Obviously, this study presents only an initial exploration and more evidence is required to validate the findings.

Firstly, the life-history interests that inform motivations can extend beyond the learning task at hand.

Consider the learning between **Galileo and his contemporaries**.

Galileo was great at learning, but bad at making friends.

His contemporaries were poor social learners, but their decision to conform with the powerful was the right life-history move.

Secondly, experimental design and interpretation must be made with better awareness of underlying cognitive mechanisms.

For instance, human subjects may be more responsive to coarse motivational cues than abstracted game theoretic descriptions, even though the latter represents more complete and accurate information.



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Extra Credits

Thank you to the folks at **Jyväskylä** and **St. Andrews** who helped pilot the experimental battery.

Special thanks to the **University of St Andrews** for their patronage and **Craig Tough** for his hospitality.

This research was supported by a **Mobility Grant** from the **University of Jyväskylä** and a **Templeton Foundation Grant** for **Kevin Laland**.

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Shameless Plug

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