Abstract: Social transmission of relevant innovations, one of the principal reasons of human success, is relevant in most of primates' behaviors, even if through different learning strategies. Niche Construction perspective, supporting the idea that each individual has a significant role in creating innovations, and Social Learning strategies, understanding the position of each learner in diffusing new techniques, give us the right frame to model the widespread of innovative procedures in a social group. It has been demonstrated that group structure influences the spread of ideas and that primate coordinate their movements in experimental contexts. We put forward a consideration on how coordination is a vital part of social learning and niche construction.

Introduction: The context in which a given behavior is shown is changed by the actions that other members (mainly adults) of the social group display for surviving. This includes choosing a gathering environment, choosing between useful and useless objects, feeding, and leaving waste [1]. In learning to survive, individuals may either adopt solutions that have already been discovered or they may themselves invent new solutions [2]. These new solutions can be transmitted to the other members of the group via Social Learning (SL) [3]. In this context, it is possible that these new solutions become part of the traditions/culture [4]. This depends, not only on the structure of the group but also on the cognitive capacities of the species [5,6]. As Niche Construction (NC) Theory has conveniently demonstrated in evolutionary context [7,8], individuals' behavioral sequences, once displayed, can have broad or narrow evolutionary consequences [6,9]. Therefore, for understanding the spread of innovative procedures, it is necessary to observe all the main elements involved in spreading innovations: (i) the innovation's intrinsic value, (ii) the innovator's position (in the group) (iii) the objects involved (if any) in the innovative procedure, (iv) the presence, relative importance and capacity of the learners, (v) the relationship between innovator and learner and (vi) the structure of the social group to which both innovator and learner belong. However, in order to spread and/or learn an innovation, one must engage in coordinative effort, not only coordinating wills but also capacities. It has been shown that primates naturally synch their movements, and that coordination arises spontaneously through verbal or visual communications [9]. In this context, NC helps in modeling the spread of innovations by hypothesizing that transmission happens through three different channels: (i) SL strategies, (ii) environmental objects [5] and (iii) coordination of individuals.

Methods: NC theory can be modeled by a series of steps that factor in the possibility for an innovation to spread or die out. Here we present a box model (Fig. 1) of what these steps might be. Because NC is highly complex to model, we focus on the coordination problem. Here we model a stag-hunt game (based on Moreira et. al. [11]) on a well-mixed finite population (N=50) and focus on the fixation probability (Φ) (eq. 4) (that is, the probability that the system fixes in a monomorphic state starting from a given number of coordinates) [12]. Because under neutral selection (w → 0) the fixation probability reads \( \Phi = 1/N \), for any given \( \nu \), whenever \( \Phi > \Phi^* \), natural selection favours coordinative behaviour, and whenever \( \Phi < \Phi^* \) the fitness equation determines whether the innovator pays attention to his neighbours, and substitute the normal terms TRPS (Temptation, Reward, Punishment and Sucker's Payoff) for payoff values (eq. 1). Whenever a coordinator finds another, she teaches the innovation and helps it spread. However, when a coordinator finds a slacker, she gets cheated and the innovation is not used but passed on, implying costs to the coordinator. Moreover, if she pays attention to what her neighbours did, she can promptly reciprocate a neighbour's past action, i.e., refraining from teaching the innovation. The more neighbours she pays attention to, the less likely she is cheated again. Individuals update their strategy by copying those perceived as fitter with a probability \( u \) (eq. 2) known as pairwise comparison rule [12]. F,F, stands for fitness difference and \( w \) represents errors, which means that individuals can actually copy less successful counterparts.

Discussion and Conclusion: Our model exemplifies a simple process in which paying attention to and remembering past actions of neighbours can facilitate the spread and fixation of coordinative strategies. This fixation is also influenced by selective pressures which affect the proportion of individuals who can be successful as coordinators in a given population. In effect, coordination can survive in a population [13] without this ability, but paying attention decreases the fraction of coordinators necessary for successful strategies to spread. In this sense, a NC perspective facilitates modeling social transmission of new behaviors and strategies because it implies that: 1. neighbours' actions are important per se, modifying learners' surroundings; 2. the focal individual is proximate to a learner during her activities; 3. the learner spends her time and energy in trying to copy successful innovations; 4. Interactions among individuals are simple and stable; 5. Different strategies reach different fitness advantages and could be learned passively or actively, because learners acquire skills directly from products and consequences of past strategies. By considering coordination as part of the NC framework, we are able to not only describe possible novel evolutionary directions of behavioural sequences but also predict such sequences.