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STUDIES

A developmental and evolutionary theory of punishment

Une théorie développementale et évolutive de la punition

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Summary Punishment and its avoidance are foundational to organisms' behavior and evolutionary development. How do responses to unfavorable situations change across animal species? We address this question using a model of developmental and evolutionary complexity (Model of Hierarchical Complexity). Tasks are ordered in terms of an ordinal scale that measures difficulty (Order of Hierarchical Complexity). Successful completion of a task at a particular order is the behavioral stage of the organism on that task. This model applies to non-human and human-animals. Examples of organisms that perform tasks of punishment avoidance at each order are provided. The Model provides a useful way of explaining the differences between organisms that is consistent with evolutionary data. We argue that as animals become more complex, punishments become more harmful, but used at decreasing frequencies. However, punishment does not disappear at even the highest stages.

MOTS CLÉS
Animaux ;
Évènements aversifs ;

Résumé La punition et son évitement sont à la base du développement comportemental et évolutif des organismes. Comment les espèces animales diffèrent-elles au niveau de leurs réponses aux situations défavorables? Nous examinons cette question en utilisant un modèle de complexité développementale et évolutive (modèle de complexité hiérarchique).

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Évitement des punitions ;
Modèle de complexité hiérarchique ;
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Punition

Les tâches sont ordonnées selon une échelle ordinale qui mesure la difficulté (ordre de complexité hiérarchique). La complétion d'une tâche liée à un ordre particulier est l'étape comportementale de l'organisme chargé de cette tâche. Ce modèle s'applique aux animaux non humains et humains. Des exemples d'organismes qui effectuent des tâches d'évitement de punition à chaque ordre sont fournis. Le modèle fournit une explication utile des différences entre les organismes conforme aux informations sur l'évolution. Nous soutenons que lorsque les animaux deviennent plus complexes, les punitions deviennent plus sévères, mais utilisées à une moindre fréquence. Cependant, la punition ne disparaît pas complètement, même aux plus hautes étapes.

A developmental and evolutionary theory of punishment

This paper is a minimalist account of the evolution and development of the behavioral consequence of punishment. It will discuss the four consequences of operant conditioning: positive reinforcement, negative reinforcement, positive punishment, and negative punishment. The four consequences develop as a function of stage of development. This paper will first describe punishment, followed by the behavioral-developmental stages.

Punishment can be defined as an aversive event or stimulus that an animal moves away from or avoids. Avoidance of punishment is evolutionarily advantageous. Punishment is presented after a behavior is expressed in order to discourage the behavior. Animals decrease or attempt to decrease the likelihood of the punishment occurring in the future. Non-human and human-animals have evolved to avoid punishments and obtain reinforcements, or stimuli that encourage survival and procreation. Punishment and its avoidance support the ''survival of the fittest'' evolutionary theory by ensuring that animals evolve to become more efficient at searching for pleasant stimuli and avoiding aversive stimuli. This paper provides an analysis of the evolution of punishment by explaining the behavioral-development stages of the Model of Hierarchical Complexity [1] and organisms' sensitivity to aversive events.

Behavioral-developmental stages of non-human and human-animals can be assessed using the Model of Hierarchical Complexity [2]. The model organizes non-human and human-animals according to each stage and task accomplishment. Each stage corresponds with specific tasks. Higher-order tasks are defined in terms of the lower ones, organize the next lower actions, and organize the lower actions in a non-arbitrary way [1]. In relation to punishment, more complex of behavioral-development have been associated with stronger power to punish, but occurs less frequently.

The tasks assessed in the Model of Hierarchical Complexity provide explanations for how non-human and human-animals respond to stimuli. These responses can be automatic or learned reflexes which are involuntary, neuromuscular and automatic in nature. Environmental stimuli elicit reflexes: involuntary, automatic, neuromuscular responses that can be built-in or learned. Lower-stage organisms mostly respond to stimuli reflexively. Through classical conditioning, animals can learn to respond to a given stimulus in a new way. Two stimuli are presented as a pair. The first stimulus to be conditioned (NS) precedes an associated built-in unconditioned stimulus (UCS), which in turn elicits a reflexive response. Repeated presentation of the two stimuli links the to-be-conditioned stimulus to the unconditional stimulus that elicits the targeted response. This form of learning can be exhibited by animals throughout all stages of the Model of Hierarchical Complexity. The tasks for each stage are more complex than the tasks for the previous stage.

In this paper, we argue against using the legal notion of punishment. The legal notion assumes intentions. The intention is not observable. It is inferred from the behavior, especially in legal use. The legal use opposes the continuity of behavioral control between human-animals and other animals. Animals from mice, rats, and pigeons plan their attacks. They are not just reflexive. They also predict their own behavior and act as if the other animal is also planning. An example is if there are two pigeons in a cage and one is shocked. The one who is shocked will attack the other one. They act as if the other pigeon caused the shock. We use the behavioral functional notion of punishment and not a legal one.

Operant conditioning pairs a behavior with a stimulus consequence, either reinforcement or punishment. By definition, a reinforcement is stimulus consequence which increases the likelihood of the behavior occurring in the future. In operant conditioning, both positive and negative reinforcements increase the frequency of behaviors. Positive reinforcement is the presentation of a stimulus consequence after a behavior and negative reinforcement is the removal of a stimulus consequence after a behavior. Punishment decreases the frequency of that behavior in the future. Positive punishment refers to the presentation of a stimulus consequence, and negative punishment refers to the removal of a stimulus consequence.

Assortativeness & Affiliativeness

Assortativeness is showing a preference for membership in a group whose members share a large number of characteristics. Part of assortativeness is to defend one's own group and aggress against or punish, other groups that do not share those characteristics. Assortativeness might lead to the formation of actual and virtual terrorist groups in that individual, even when living within a seemingly benign culture, may still feel a strong affiliation with a different group, while having shifting levels of affiliation with the relatively benign group around them. On the other hand, affiliativenesss promotes social cohesion by being inclusive and minimizes punishment.

How Punishment Drives Evolution

The avoidance of punishment has led to evolutionary adaptations that promote fitness, survival, and procreation. Predation, dominance signals during mating periods, social dominance, and territorial dominance are exhibited by animals. Predation, for example, the act of an animal killing and eating another, is a selective evolutionary force [3]. The prey is punished in every interaction, either by being killed and eaten or by being treated with violence. Punishment in specific interactions with a predator elicits a fear response in the prey and leads to future avoidance of the predator through improved detection of the predator and escape ability.

Predation

From a broader evolutionary perspective, prey has evolved to innately fear predators, even without experiencing firsthand punishment interactions [4]. German measured the speed at which participants could detect in their peripheral vision images of threatening objects: black widow spiders (an ancestral threat), hypodermic needles (a modern threat), and houseflies (a fear-irrelevant animal). The spiders were detected far more quickly than the needles or the houseflies despite the prevalence of firsthand punishment interactions with needles and the extreme rarity of firsthand punishment interactions with black widow spiders. This study supports the hypothesis that our human ancestors' interactions with predatory threats have resulted in the evolution of biological fear and avoidance of animals such as the black widow spider. Thus, non-human and human-animals' fear of predators can either be evolutionarily ingrained or conditioned. Fear and avoidance can be viewed as conditioned responses to specific interactions, and also seen in whole species as a result of evolution.

In their role as predators, animals have evolved to detect and kill prey more easily and efficiently. The ''survival of the fittest'' theory of natural selection has been supported by Genovart [3]. His study on predation of seagulls, where seagull predators were found to preferentially prey on substandard individuals. Age, muscle condition, and sickness were used to determine an individual's status as standard versus substandard. Predators preferred to kill juveniles, sick seagulls, and seagulls with poor muscle condition. Preying on substandard individuals is more efficient than preying on physically fit individuals who are better suited to escape the predator, making preying on weaker individuals evolutionarily advantageous. In improving their hunting skills, predators avoid the punishment of not obtaining food and staying hungry. Predators' natural selection of overall weaker prey maintains the predators' own survival and ability to procreate, as well as leaves the stronger prey to survive and procreate. In their role as prey, animals have evolved to avoid the punishment of being detected and attacked by predators.

Antipredator adaptations such as camouflage, stealth, and aggressive mimicry help animals avoid detection by predators [5]. Camouflage helps animals avoid detection by predators. Stealth describes behaviors that enable an animal to escape a predator after being detected: e.g., animals freeze under the gaze of a predator in order to play dead. Aggressive mimicry involves the display of behaviors to hinder the predator's ability to correctly identify the prey. The antipredator behaviors advantageous to prey are positively reinforced by instances of successful avoidance of detection. The punishment seen in the interactive predator-prey relationships reinforces the idea that natural selection can be a determinant of the trajectory of a species' evolutionary adaptations. Through avoidance of punishment, animals become stronger and, more efficient predators as well as stronger prey that are more successful at avoiding detection and being killed.

Dominance signals and the assertion of social and territorial dominance are often used as mating behaviors and have evolved from the instinctual avoidance of punishment. Dominance signals involve communication of information about an animal's physical fitness and are usually exhibited by a male in competition with other males. Signals help to maintain social order by resolving or reducing the frequency of conflict between males and help to organize and maintain social hierarchies as well as defend territories [6]. Communication through signaling takes place when the signaller produces a visual, acoustic, tactile, or electrical signal that conveys a message and elicits a signal response from the recipient. One of the two individuals' dominance is reinforced. In mating behaviors, male animals typically express dominance signals to communicate their interest in a potential mate, in which the female then decides whether they want to engage in the mating behavior. When two males are in competition for the same female, the power of the signals may indicate the male animals' genetic success, determining how attractive they might be to the female and influencing her choice of mate. Dominance signals can be used for communication between members of social hierarchies, usually to make a dominant and subordinate relationship clear between two individuals. Signals are crucial for harmonious social order, especially for aggressive animals. For Example, if one animal of a low position in a hierarchy initiates a competitive interaction with an animal of a high position in the same hierarchy, the dominant individual will use displays and signals to communicate its strength. The weaker individual responds by ceasing its aggression. Communication by social dominance signals can end aggressive interactions before they can become physical altercations. Thus, signals function to help animals avoid the punishment of violent physical contact.

Signals can also be used to avoid punishment within the context of territorial dominance. Groups of animals inhabit territories where they can acquire food, create nesting sites and mating areas, and attract mates. Animals defend these territories by using communication signals such as scent marking, visual signals such as feces or marks on the ground, or auditory signals such as vocalizations. If an intruder passes the signals into the group's territory, the intruder and the territory-holder may engage in ritualized aggression using dominance signals. The signals allow animals to communicate without having to risk physical injury. If one of the two animals does not flee, then the two may begin to physically fight.

Territorial dominance minimizes the risk of two kinds of punishment. The first is the punishment of being injured in a physical fight that may occur between a territory-holder and an intruder. The risk of this punishment is minimized through the use of communication signals. The second type of punishment that is avoided is a threat posed by an intruder on a group's ability to survive and procreate by feeding on their food sources, destructing their nesting site, or by injuring their group members, especially young ones. The intruder could also be a competitor for paternity, and attempt to mate with members of the group. This could perpetuate the intruder's genetics instead of the genetics of members of the group. Territorial dominance helps animals avoid punishment in the form of physical injury and threats to their survival and procreate. This improves the group's fitness, supporting the theory of natural selection.

Punishment in Humans

Punishment leads to distinct reactions in humans as well. Psychological research on operant conditioning has found that punishments lead to fear and avoidance. In a study by Watson & Rayner [7] they used operant conditioning to successfully instil the fear of a white rat in an infant boy. The baby (little ''Albert'') initially showed no signs of fear when the rat was presented. However, Watson began to bang a hammer on a steel drum every time the baby would touch the rat. This created a loud noise, that eventually caused Albert to cry and attempt to crawl away at the sight of the rat. Eventually, he would cry and crawl away when the rat was presented, even without the accompanying loud sound. The conditioned fear was so salient that he even generalized his fear to all furry objects, including a Santa mask, a rabbit, and a dog. In this case, conditioned punishment resulted in the establishment of strong fears and physical avoidance of the stimulus. In addition to conditioning fear in individuals, it is also possible to remove instilled fears in certain circumstances. One way to do this is through the process of desensitization. In a study by Jones [8], a three-year-old boy who was afraid of rabbits was given a reinforcement (food) when presented with a rabbit (unconditioned stimulus). His fear responses such as crying and high blood pressure lessened after increased exposure to the pairing of the two stimuli. This is an example of how reinforcement in operant conditioning can reverse the fear and avoidance responses to punishment.

Another example in which fear is not present can be seen in Milgram's study of human participants' behavior [9]. The participants were given a task of administering a series of increasingly painful electric shocks to an unseen, anonymous person by an authoritative figure. The victim was merely a volunteer and was not harmed. However, the results identified that 65% of the participants administered the highest voltage to the victim. The Milgram experiment demonstrates how moral fear can be overwritten when responsibility is delegated off of the direct actor, resulting in punishment at different severity ranges. The Milgram experiment participants' relationship with punishment could be explained by the behavioral-developmental stages of the Model of Hierarchical Complexity. The people who refused to administer the highest voltage might perform at higher behavioral stages than those who followed the instructions. It is the use of logic, perspective-taking, and problem-solving that develop individuals' moral reasoning. Logical reasoning is the recognition of causal relationships that are grounded in reality. Perspective-taking is the act of understanding views other than one's own. Low performance on logical, perspective-taking, and problem-solving tasks is associated with punishment. The progression from lower human stages to higher human stages leads to the less frequent use of more severe punishment.

The Model of Hierarchical Complexity

The Model of Hierarchical Complexity is a mathematical measurement theory [10,11]. The model is a non-mentalistic, neo-Piagetian and quantitative behavioral-developmental theory that analyzes the developmental difficulty of tasks. The model organizes task complexity. It proposes that tasks can be ordered in terms of their hierarchical complexity using an equally spaced unidimensional ordinal scale. It is used to predict the difficulty of behavioral tasks independent of domain and content[1].

The Order of Hierarchical Complexity refers to the number of times that the coordinating actions must organize lower-order actions. The hierarchical complexity of an action is determined by decomposing the action into the two or more simpler actions that make it up. This iterative process is done until the organization can only be carried out on a set of simple elements that are not built out of other actions. Actions at a higher order of hierarchical complexity can be described by several traits:

- they are defined in terms of actions at the next lower order of hierarchical complexity;
- organize and transform the lower-order actions;
- produce organizations of lower-order actions that are new and not arbitrary, and cannot be accomplished by those lower-order actions alone.

Once these conditions have been met, the higher-order action coordinates the actions of the next lower order. An example of the application of these axioms is shown in Fig. 1. Using these axioms, it has been shown that tasks can be categorized into 17 Orders of Hierarchical Complexity (Table 1). The order of hierarchical complexity is obtained by counting the number of hierarchical steps, with each step consisting

[1] For a comprehensive review, see [12].

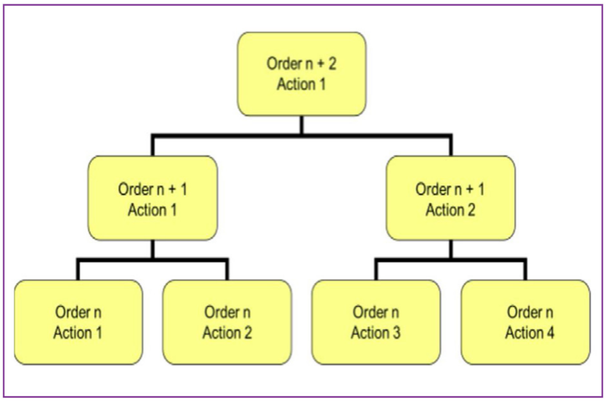

Figure 1. Coordination of actions.
Coordination des actions.

of coordination of lower-order actions. An organism is said to be operating at a stage when it successfully completes a task at that order of hierarchical complexity but has not successfully completed a task at the following order.

The Order of Hierarchical Complexity (OHC) is an equally spaced unidimensional ordinal scale. It is used to assess the predicted difficulty of tasks. It measures difficulty independent of domain and content. The OHC begins with simpler behaviors and progresses to more complex behaviors. How does behavior become more complex? As we will show in some detail below, complex behaviors are built out of the earlier, simpler behaviors. The higher the order of hierarchical complexity, the greater the difficulty of the task gets. The Model of Hierarchical Complexity puts actions into an order based upon how hierarchically complex they are.

The model proposes a set of axioms that explains how more complex tasks are built out of less complex tasks. As a result, the model also allows for the classification of tasks based on their complexity. A task action is defined as a more hierarchically complex when the higher-order action:

- is defined in terms of two or more actions from the next lower order;
- organizes these lower-order actions and;
- does so in a non-arbitrary way.

The three axioms above deconstruct tasks into the actions, which must be completed at each order, to build the behavior needed to successfully complete a task. Thus, the order of hierarchical complexity is obtained by counting the number of hierarchical steps. Each step consists of coordination of lower-order actions. Hence, there will be three hierarchical steps in an Order 3 task. If an action organizes two or more actions from an order before it, that organizing action is by definition one order higher and is, therefore, more hierarchically complex.

Fig. 1 demonstrates the coordination of same-order lower task actions by higher-order task actions across two orders of complexity. Starting at the bottom of the figure, four tasks of order n are non-arbitrarily coordinated to form two tasks of order n + 1 and then two tasks at order n + 1 coordinated to form a task at order n + 2.

The model is based on the assumption that a large number of tasks and task sequences exist in the environments of all animals, whether humans or not. These sequences exist in different domains of behavior including problem-solving, personal, social and other domains. In animals' natural environments, these tasks might, for example, be directed toward obtaining food and reproduction. For some animals, the task of obtaining food may consist primarily of a simple, reflexive action, as in an amoeba ingesting a possible food item through phagocytosis. For other animals, several different subtasks may be coordinated together, including searching for food sources, using or making tools to take advantage of a food resource, hunting a food source, coordinating actions with conspecifics, and so on. For the many species of animals who are studied in scientific laboratories, using both natural and more artificial tasks, and for humans, who engage in a large number of natural and artificial (or humanly created) tasks, the number of possible tasks and task sequences can be large indeed.

The model is used as a general, unidimensional developmental measure of difficulty across domains. Dawson-Tunik's [14] studies have found that the stage of development scored according to the model of hierarchical complexity was consistent with multiple other instruments that were designated to score development in specific domains. The performed actions may or may not perfectly complete a given task. Actions are defined as behavioral events that produce potentially observable outcomes. Actions may be attributed to organisms, social groups, and computers. Actions may be combined to produce new, more hierarchically complex actions [15]. The different layers in a hierarchical sequence of task complexity are referred to as orders.

It is based on vertical complexity and involves hierarchical information. Hierarchical complexity refers to tasks that require the performance of lower-level subtasks in order to perform more complex, higher level tasks. The most important advantage of the model of hierarchical complexity is that there is only one sequence of order of hierarchical complexity of tasks in all domains [16]. The model is applicable to any domain of development in both humans and animals, such as social, cognitive, personal and such. MHC also seems to have an advantage over previous proposals about the developmental stages of humans. While previous models attribute behavioral changes across a person's age to the development of mental structures, MHC posits that task sequences of task behaviors form hierarchies that become increasingly complex. According to this model, less complex tasks must be completed and practiced before more complex tasks can be acquired. Thus, it accounts for developmental changes.

Furthermore, previous theories of the stage have confounded the stimulus and response in assessing stage by simply scoring responses and ignoring the task or stimulus. The model of hierarchical complexity separates the task or stimulus from the performance. The participant's performance on a task of a given complexity represents the stage of developmental complexity. Another factor which sets this model apart from previous models is that it not only extends developmental stages up to 17 stages but also includes subtasks and sub subtasks which explain what happens between those stages.

Table 1 Stages described in the model of hierarchical complexity [13].
Étapes décrites dans la modèle de complexité hierarchique.

Stage Number	Stage Name	What they do	End result	Animals
0	Calculatory	Exact computation only, no generalization	None	None
1	Automatic	Engage in a single ''hard-wired'' action at a time, no respondent conditioning	Single celled organisms respond to a single stimulus in a way analogous to this stage	Unicellular organisms, amoeba, *physalum polycephalum*
2	Sensory or Motor	Discriminate in a rote fashion, stimuli generalization, move	Discriminative establishing and conditioned reinforcing stimuli	Aplysia, molluscs, starfish, Drosophilia Larvae
3	Circular Sensory-motor	Form open-ended proper classes	Open ended proper classes, phonemes, archiphonemes	Catfish, insects and invertebrates, honeybees
4	Sensory-motor	Form concepts	Morphemes, concepts	Rats, pigeons
5	Nominal	Find relations among concepts	Single words: ejaculatives & exclamations, verbs, nouns, number names, letter names	Dogs, cats
6	Sentential	Imitate and acquire sequences; follow short sequential acts	Various forms of pronouns: subject (I), object (me), possessive adjective (my), possessive pronoun (mine), and reflexive (myself) for various persons (I, you, he, she, it, we, y'all, they)	Parrots
7	Preoperational	Make simple deductions; follow lists of sequential acts; tell stories	Connectives: as, when, then, why, before; products of simple operations	Rhesus monkey
8	Primary	Simple logical deduction and empirical rules involving time sequence; simple arithmetic	Times, places, counts acts, actors, arithmetic outcome, sequence from calculation	
9	Concrete	Carry out full arithmetic, form cliques, plan deals	Interrelations, social events, what happened among others, reasonable deals, history, geography	Chimpanzees, bonobos
10	Abstract	Discriminate variables such as stereotypes; logical quantification; (none, some, all)	Variable time, place, act, actor, state, type; quantifiers (all, none, some); categorical assertions (e.g., ''We all die'')	Humans
11	Formal	Argue using empirical or logical evidence; logic is linear, 1-dimensional	Relationships (for example: causality) are formed out of variables; words: linear, logical, one-dimensional, if then, thus, therefore, because; correct scientific solutions	Humans
12	Systematic	Construct multivariate systems and matrices	Events and concepts situated in a multivariate context; systems are formed out of relations; systems: legal, societal, corporate, economic, national	All professional humans

Table 1 (*Continued*)

Stage Number	Stage Name	What they do	End result	Animals
13	Metasystematic	Construct multi-systems and metasystems out of disparate systems	Metasystems and supersystems are formed out of systems of relationships, e.g. contracts and promises	Humans
14	Paradigmatic	Fit metasystems together to form new paradigms; show ''incomplete'' or ''inconsistent'' aspects of metasystems	Paradigms are formed out of multiple metasystems	Humans
15	Cross-paradigmatic	Fit paradigms together to form new fields	New fields are formed out of multiple paradigms	Humans
16	Meta-cross-paradigmatic (performative-recursive)	Reflect on various properties of cross-paradigmatic operations	The dynamics and limitations of cross-paradigmatic thinking are explained as they are recursively enacted	[Humans and androids]
17	Ultra-human	Not yet known	Not yet known	Not yet known

Non-Human and Human-Animal Stages

Below is a list of species for which the investigator has ascertained the stages and task descriptions. For each species or species group, there is published an account of its behavior, which the investigator scored for the stage of development. As can be seen, each species is placed at the stage at which their behavior was scored.

Automatic Stage 1

At the Automatic Stage 1, a single action is an innate biological response to a single environmental stimulus. This stimulus is not paired with any other stimulus. Examples of the environmental stimulus could be a chemical emitted by possible food or a physical stimulus such as light. The actions are ''hard wired'' into the organism. Examples include photo-taxis, tropisms, phagocytosis and unconditional reflexes. The organisms that perform these actions are single-celled. While habituation and sensitization occur at this stage, they are not coordinated into classical conditioning [17]. For example, the unicellular amoeba Physarum polycephalum has been able to adapt its behavior in response to patterns of periodic environmental changes. Saigusa [18] exposed the Physarum to three spikes of cold temperature, which elicited the reflex in the amoeba to slow down its movement speed. The temperature spikes occurred at a set rhythm at regular intervals. Eventually, the spikes were not administered at the time that would follow the pattern, but the Physarum still slowed down its speed at the appropriate time. This shows an ability to alter behavior due to the recollection of past events. This ''memory pattern'' is not true learning, but the behavior changes are best described as being learned.

Sensory or Motor Stage 2

Respondent conditioning at Stage 2 of hierarchical complexity coordinates two stimulus-response pairs from the lower Automatic Stage 1. Two characteristics of this order are:

- two stimuli are paired either in a naturalistic environment or by an experimenter. In other words, an unconditioned stimulus that already elicits an unconditioned response is paired with another salient stimulus and;
- the organism's behavior does not directly cause the reinforcing stimuli in this situation as it does in operant conditioning.

Reflexes that are conditioned are also stage 2 behaviors. For example, Kemenes [19] used in vitro appetitive classical conditioning of the feeding response Pond Snail *Lymnaea stagnails*. It was shown after 6—10 conditioning trials the touch to the lips evoked a significant enhancement in the fictive feeding response to CS alone as compared to a brief and weak activity. Another example is of the leech *Macrobdella Ditetra* has been classically conditioned [20] has shown spontaneous recovery. The animals show anteroposterior contraction after being presented with an electric shock. The shock was paired with light, and the animals were conditioned to contract after being presented only with the light.

Circular Sensory-Motor Stage 3

Operant conditioning is a Stage 3 action. It is built out of the non-arbitrary coordination of three Sensory or Motor Stage 2 task actions or steps. These steps are: Step 1, ''What to do''; Step 2, ''When to do it''; and Step 3, ''Why to do it'' [2]. The three steps of respondent conditioning are from Stage 2 but are not coordinated until Stage 3. Three very different cases of procedural respondent conditioning are

Table 2 The four consequences of operant conditioning.
Les quatre conséquences du conditionnement opérant.

	Presentation of a stimulus	Removal of a stimulus
Behavior increases	Positive reinforcement	Negative reinforcement
Behavior decreases	Positive Punishment	Negative punishment

used. The only commonality between the three respondent conditioning steps is the basic procedure. Those procedural steps are the ''What to Do'' (step 1), ''When to Do'' (step 2) and ''Why to Do'' (step 3).

In step 1 of the respondent conditioning, the representation of behavior takes on the selective properties of the SR+ making the representation of behavior salient. We leave the representation of behavior undefined. One might use common notions of it instead. In step 2, the now salient representation of behavior (rb) is paired with an environmental S. This makes the S elicit the representation of behavior which requires the saliency of the representation of behavior. In step 3, the environmental S is paired with the SR+ making the S more salient and valuable. When the environmental stimulus is more salient, the representation of a behavior rate relative to other representation of a behavior's not associated with reinforcement increases (Table 2).

For example: Drosophila melanogaster has been operantly conditioned in a laboratory environment [21], so they have performed a Stage 3 task. No Stage 4 tasks were found in a literature search. Therefore, the highest stage observed is Stage is 3. Another example is the Aplysia Californica, which demonstrated operant conditioning. Siphon shocks were administered to their gills when relaxed. The animals responded by contracting their gills for longer periods of time than did the control animals so as to avoid the siphon shock punishment [22].

Erber et al. [23] trained honeybees (Apis mellifera) to move their antenna muscles to receive sugar water. This coordinates an arbitrary muscle motion with a reinforcing. This simultaneously associatively conditions the bee to associate the touching of the stimuli objects with the reinforcing of sugar water, in that non-arbitrary order. This pairs two order 2 behaviors into an order 3 task. The only challenge to stage 3 being the ceiling of the stage that honeybees reach is the waggle dance [24]. The waggle dance is a form of communication, in which the bee moves its body in a particular way, in order to indicate to the rest of the hive that they have found food. After seeing the bees' waggle dance, the others are able to navigate their way to the aforementioned food with few errors. This behavior of following the directions exhibited by the waggle dance is an example of non-arbitrary sequence of operant (stage 3) behaviors. However, these behaviors consist of simply following a sequence of motions over time. This paper argues that providing or following such a sequence is actually a long chain of Stage 3 tasks, rather than a Stage 4 task. This argument is supported by the notion that the waggle dance may not be learned behavior. Ai and Hagio [25] found evidence that there is considerable specialization in bee anatomy that assists in the performance and response to this dance. In this case, it would be an operant procedure requiring a tremendous amount of sequential coding. For the purposes of this paper, the waggle dance is a very horizontally complex order 3 task.

Neveu [26] found that Rana esculenta could be trained to eat pellets, despite the fact that in the wild they only eat things that move. In this process, the frogs are performing not only the order 2 task of learning to treat new substances as food but also a whole new order 3 eating procedure (Table 3).

Sensory-Motor Stage 4

At Sensory-Motor Stage 4, organisms coordinate 2 or more circular sensory-motor subtask actions into a superordinate ''concept''. New and untrained instances of the concept are responded to correctly. These correct responses do not depend on simple stimulus generalization.

The following is a description of Stage 4 behavior in rats. Rats were repeatedly presented with three scented stimuli. Two were always of identical scent, while the third was always different from the other two. The scents were different in every trial. Reinforcement was received for selecting the third stimulus that was scented differently from the other two [27]. They had to discriminate what is termed oddity matching. This is an order 4 task, which coordinates multiple order 3 operant contingent behaviors. A literature search did not find any more hierarchically complex tasks than this performed by rats; therefore rat is operating at Stage 4.

Watanabe et al. [28] demonstrated that mice can be conditioned to discriminate between the paintings of different artists. This process coordinates multiple Stage 3 (operant) cues to see the conceptual differences between paintings. The example behaviors for rats were originally obtained from an unpublished paper by Miller, Commons, Commons-Miller, and Chen.

Nominal Stage 5

Characteristics of Stage 5 include responding to words that represent concepts. They also follow sequences of word commands. A single word command is stage 4, sequences of them is stage 5. Dogs have shown responses to verbal stimuli [29,30]. Dogs respond to verbal commands divided into the following categories: disallowance, posture, invitation, referring to object or person, unique, information giving, permission, and question [30]. These utterances may consist of one or more words.

Dogs understand the concepts involved in commands. They may generalize their responses when presented with previously unknown commands or contexts [31]. A process

Table 3 How operant conditioning is built out of respondent conditioning?
Comment un conditionnement opérant est construit sur un conditionnement répondant?

Step 1: S_{Drive}	→	$S_{Consequence}$
Step 2: $\underline{s_{rb}\text{-}R}_{\text{''Operant''}}$	→	S^{R+}
Step 3: $S_{Environment}$ *o* $s_{rb}\text{-}R_{\text{''Operant''}}$	→	$R_{\ Conditioned\ Reflex}$
Step 4: $S_{Environment}$ *o* S^{R+}	→	$R_{\ Incentive}$

known as fast mapping has been shown to increase dogs' vocabulary [32]. Through the application of cognitive rules, a dog is able to learn the meaning of a word after only a single exposure within a familiar context.

Sentential Stage 6

A characteristic of Stage 6 is following sequences of Stage 5 representations of concepts. An example of this in humans is constructing sentences. Stage 6 depicts imitate and acquire sequences. It follows short sequential acts; generalize match-dependent task actions; chain words together. Use pronouns.

Chen [33] performed a study where Capuchin monkeys were given tokens to trade for reinforcing. In this study, the Capuchin participants successfully exchanged tokens for different food reinforcements based on the preferences of the individual participant and changed the exchange rate of token for the different kinds of food reinforcements. The fact that the Capuchin monkeys changed their buying habits in response to changes in price shows that they can accurately respond to multiple values for the same token. Using a token to represent a single concept is a Stage 6 task. Using the same token differently in different contexts coordinates multiple Stage 5 tasks into Stage 6 task.

Preoperational Stage 7

A characteristic of Preoperational Stage 7 is making simple deductions; following lists of sequential acts, and telling stories. Stage 7 counts random events and objects; it combines numbers and simple propositions. It also uses connectives: as, when, then, why, before; products of simple operations.

The behavior of the following small non-ape primates was deemed to be similar enough to squirrel monkeys that the same scoring could apply to these animals: Preoperational stage 7 Organisms form lists of organized sets of acts and make simple deductions that connect simple sequences of actions (without contradiction excluded). A human telling a story, for example, is like a sequence of sentences. One of the end results includes that organisms can count random events and objects placed in a row or presented in a sequence, combine numbers, and combine simple propositions.

Washburn and Rumbaugh [34] trained Rhesus monkeys to select Arabic numerals associated with a number of food pellets. This task coordinates the Stage 6 sequence of numerals with the Stage 6 sequence of numbers of objects to create a Stage 7 action.

Primary Stage 8

A characteristic of Primary Stage 8 is having the simple logical deduction and empirical rules involving time sequence. It includes using simple arithmetic. We can add, subtract, multiply, divide, count, prove, do a series of tasks on own in this stage. Logical deduction and empirical rules are applied in Primary Stage 8. Moral reasoning is being developed in humans. Actions are justified in terms of avoiding punishment and obtaining rewards. People are seen as an individual, with unique behaviors and preferences.

Concrete Stage 9

Characteristics of Concrete Stage 9 are to carry out full arithmetic, form cliques, and plan deals. It also does long division, follow complex social rules, take and coordinate perspective of others and self. Use variables of interrelations, social events, what happened among others, reasonable deals. The instances are actual because they occur in the past or present time. They are composed of specific things, incidents events, actions, actors, and places. Concrete Stage 9 actions are applied to a small number of specific instances.

Gomes and Boesch [35] found that chimpanzees engage in a variety of trading behaviors including the exchange of meat, social support, and sex. The appraisal of value for a good or service is an order 7 task. To make a deal requires the non-arbitrary coordination of two or more such values, and it is, therefore, Stage 8 task. Punishment is avoided when two individuals make a deal. The deal coordinates self and others, so the individuals are engaging in perspective-taking while simultaneously seeking out their own rewards.

For humans, others' perspectives are considered only if those others affect oneself or one's close group or enable deals that both parties regard as fair. People operating at the Concrete stage only take others' perspectives in order to obtain a reward or avoid a punishment.

The Concrete Stage begins at the onset of post-elementary school education and extends across the life span of all but a small portion of the population. This period generates the conventional norms of adulthood. Reasoning at each stage of this period contains enough logic that it can find its most elaborate expression in some current adult philosophy.

Abstract Stage 10

Characteristics of Abstract Stage 10, humans discriminate variables such as stereotypes; use logical quantification; form variables out of finite classes based on an abstract feature. Make and quantify propositions; use variable time, place, act, actor, state, type; uses quantifiers (all, none, some); make categorical assertions (e.g., ''We all die'').

Human beings have a much wider range of developmental stages than any other animal. In Commons [36] at Stage 10, humans coordinate a number of concrete instances of events, example, etc. to form variables. This allows for relative values that include such as stereotypes, in-groups, and out-groups. Also emergent at this stage is variable quantities and qualities, as well as categorical assertions.

At the Abstract stage 10, the action is justified in terms of the reputation and characterization of the individuals or groups that are involved. People and groups can, for instance, be good or bad, nice or nasty. The action is often judged on the basis of individuals' or groups' underlying sentiments or motives. Role and person may be confused. For example, humans can form coalitions with people they have never met. They share some common characteristics, which is known as affiliativeness. Large groups can defeat small groups through the use of aversive events. Even for the early hunter-gatherers, one of the affiliate features was a trade. Affiliativeness in the form of trading keeps people from killing those with whom they are trading.

For people, punishment only has short-term benefits, which are outweighed by long-term costs. This cost-benefit imbalance is not possible until the Abstract stage because the alliances and coalitions that are formed are able to punish more severely. For example, prisoner coalitions protect the in-group members against outside threats such as social ridicule or mockery. The punishment of being beaten or killed outweighs the possible short-term benefit of asserting one's dominance.

Affiliativeness dominates assortativeness in humans. Affiliativeness and prosocial behavior are hallmarks of being human. Humans' affiliativeness explains why humans are dominant over chimpanzees. In other animals, assortativeness is dominant and there is no affiliativeness. For human societies, dictatorships control their populations by punitive means. They ultimately fail because there is too much intergroup conflict. The use of punishment and aversive events is decreasing around the world.

Formal Stage 11

At Formal Stage 11, humans coordinate two variables into one-dimensional linear logic. Analytic examples of this include syllogistic logic and univariate algebra. In univariate algebra, simple equations with one unknown (a variable) are solved. One gets a relationship between y, the dependent variable, and x, the independent variable.

Logic and empirical tasks are used to deal with aversive events. When aversive events occur, blame is assigned to either oneself or others, but not both oneself and others. Only one cause of an aversive event can be understood at a time. One person is blamed even though another person may have been involved to some extent.

The reasons given for labeling an action as fair and good are logical and abstract. Bureaucratic norms, laws, rules, and regulations guide behavior and are seen as ''given''; they are not seen as responsive to individuals or particular situations. Role and person are no longer confused as they were at the previous stage.

Systematic Stage 12

At Systematic Stage 12 humans coordinate multiple Stage 11 relationships among variables tasks. An example of this is solving systems of equations [36]. Not only are humans born at stage one, but also stages 9—15 have only been observed in humans. Most working professionals operate at this stage. Constructing multivariate systems and matrices, coordinating more than one variable as input; situate events and ideas in a larger context, that is, considers relationships in contexts; form or conceive systems out of relations: legal, societal, corporate, economic, national operate at this stage.

Humans at this stage believe that the use of aversive events is often effective and necessary. They do not look across history and notice a huge decrease in the use of aversive events. They do not see the alliance from mid to long-term work better and do not have negative side effects. The power to punish increases. Punishment never disappears, but its frequency decreases.

At the Systematic stage, the yardstick for evaluating the morality of an action is the preservation (or destruction) of a system or a society. Norms, laws, rules, and regulations form a logically coherent system. People at this stage reason in terms of how an action, could affect one's individual role and status within the system, as well as on the system's capability to function. Hence, there is a tension between societal and personal rights on one hand and societal and personal duties on the other. For the individual, part of this tension is a conflict between independence from and dependence on both others and the system.

Metasystematic Stage 13

At the Metasystematic stage, some appellate court judges and innovative researchers mostly perform at this stage. Very few (less than 2%) of humans have been found to perform at stage 13 or above [37,38]. The metasystematic stage begins sometime after adolescence; however, the fully metasystematic behavior appears after early adulthood [39]. In any known society, only a small portion of members achieves metasystematic stages of reasoning.

People see that there have been a variety of laws in society. The cultural evolution is the process by which the laws change, and the cultural evolution is driven by increasing overall reinforcement rate and decreasing of aversive events. They look across studies for long-term outcomes as compared to short-term outcomes.

People justify actions on the basis of universal abstract principles. Many such principles can be found in the works of philosophic, political, and religious thinkers. A number of modern societies also articulate these [40]. Moral Stage 5 principles are general in their application, irrespective of the person affected. The specific content of the principles may be contingent upon the society in question. People are assumed to have different interests and expertise. Society is seen first as a creation of individuals and second as the context in which people develop. From a developmental-stage perspective, the principles coordinate duties with corresponding rights. They also coordinate dependence with the corresponding independence stances of the previous stage. Overall, then, the interests of the society and the individual are coordinated. The result is to support truly joint decision-making and autonomy.

Paradigmatic Stage 14

People operating at the Paradigmatic stage change culture long-term. They compare subfields such as criminal justice with involuntary commitment. They understand that there are no interventions or solutions that are consistent and complete. There is no group or theory that is adequate in representing an individual or a group. The use of aversive events is always addressed by the question, ''what would the least advantaged person find best?''.

A perspective process is replaced by a dialogical process, in which all people's perspectives are taken into account, including wrongdoers, caretakers, and representatives of all communities. It is understood that adaptation and representation are ongoing. The idea of sentencing someone to prison time is not understood to be an effective solution, because the punishment will not change the person's behavior.

Evolution of aversive has been there since the beginning of life, its only cultural evolution that counteracts the use of aversive for controlling human behavior.

Cross-Paradigmatic Stage 15

There are only a couple of thousand people in the world who operate at this stage at a given time. They understand that comparing paradigms such as law and mental health is necessary but woefully incomplete. They draw upon all the behavioral sciences and social science to the dilemma that they face. They also understand they live in biological and cultural evolution. There are multiple forces determining behavior at any given time.

Conclusion

This paper provides an account of the evolutionary development of the behavioral consequence of punishment. Punishment is a strong evolutionary force that has driven animals to become stronger and more efficient at survival. Non-human and human-animals have evolved to avoid aversive stimuli and obtain reinforcements, which promote fitness, survival, and procreation. The theory of natural selection is supported by the evolution of punishment and its avoidance. The use of punishment at each of the behavioral-development stages of the Model of Hierarchical Complexity becomes increasingly more severe, but less frequent. Animals performing at each stage have a higher power to punish than the animals at the previous stages. Our proposed developmental and evolutionary theory of punishment is supported by an evolutionary explanation, an explanation of why animals avoid aversive events, and a behavioral-development explanation. Punishment has existed throughout the entirety of the evolution of non-human and human-animals. The avoidance of punishment and the search for reinforcements have determined the evolutionary adaptation of non-human and human-animals.

As the behavioral-development stages of the Model of Hierarchical Complexity increase in complexity, punishment is used less frequently but the power to punish grows stronger. The development of logic, perspective-taking, and problem-solving allow individuals to use punishment less. Logical reasoning is the recognition of causal relationships that are grounded in reality. Perspective-taking is the act of understanding views other than one's own. Low performance on logical, perspective-taking, and problem-solving tasks is associated with a higher tendency to punish. The progression from lower human stages to higher human stages leads to the less frequent use of more severe punishment.

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Disclosure of interest

The authors declare that they have no competing interest.

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