

Beyond Suffering

A Framework for Quantifying Positive Animal Welfare in
Individuals and Populations

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Executive Summary

- ❖ The Welfare Footprint Project has so far focused predominantly on quantifying negative affective experiences in animals, given pain's greater impact on welfare.
- ❖ However, positive affective states also play a crucial role in an animal's quality of life, affecting long-term welfare through aspects such as immunity and resilience.
- ❖ An operational definition of pleasure is proposed.
- ❖ Categories of pleasure intensity are defined based predominantly on the degree of engagement with positive experiences.
- ❖ The Pleasure-Track notation system is proposed, allowing for the description of the temporal evolution of the intensity of positive affective experiences.
- ❖ Cumulative Pleasure is measured as the total time spent in positive affective states of different intensities.
- ❖ The framework avoids equating the intensity categories of pleasure and pain, and acknowledges the complexity of balancing positive and negative affective states.
- ❖ A graphic proposal is made for the visualization of Welfare Footprints, where they are expressed by a double bar chart representing the time spent in negative and positive affective states of different intensities (Cumulative Pain and Cumulative Pleasure).

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Introduction

To inform efforts for the prevention and alleviation of animal suffering, the [Welfare Footprint Project](#) has so far primarily focused on quantifying negative affective experiences [1], often referred to simply as ‘pain.’ This emphasis is based on the understanding that negative experiences generally have a greater impact on well-being than positive ones, often preventing the experience of positive states [2]. From an evolutionary standpoint, pain is expected to be more noticeable than pleasure, as pain signals immediate threats to survival and reproduction, whereas positive experiences tend to reinforce behaviors that are beneficial in the medium term, like social bonding, learning, optimal foraging and mating. Failing to experience pleasure is not as immediately consequential as not responding to pain. This tendency to focus more on negative than positive events, known as negativity bias, is in fact a well-documented phenomenon in humans [3].

Still, positive states also play a crucial role in shaping an individual’s quality of life, and determining the extent to which it is ‘good’ [4], or at least ‘worth living’ [5]. Positive states are not only momentarily pleasurable; they also have long-term effects that help individuals overcome adversity [6]. For example, experiences of positive affect have been shown to naturally relieve pain (through endogenous analgesia), boost resilience to stress, and improve immune function [7–9]. Accordingly, the assessment of positive affect and the identification of conditions promoting it have gained substantial traction in the animal welfare sciences in recent years [10–12].

The goal of this contribution is to expand the Welfare Footprint framework to include not only the measurement of negative experiences in animals, but also positive states, or ‘pleasure’. Since the reasoning behind this metric is similar to that for assessing pain — already discussed in prior works [1,13] (see a [8 min video](#) or a [presentation](#) at the Effective Altruism conference) — we do not describe these principles again here. Instead, we introduce the definitions and tools equivalent to those used for quantifying negative affective states, now adapted to positive affect: the operational definition of “Pleasure” and its four intensity levels (five including “No Pleasure”), the “Pleasure-Track” notation system, and “Cumulative Pleasure”. Additionally, with the full spectrum of affective experiences considered, we also introduce a visualization proposal, termed ‘Cumulative Affect’, to represent the overall Welfare Footprint of any population in a context and time scope of interest.

Operational definition of pleasure

We propose an operational definition of pleasure directly derived from the operational [definition of pain](#) previously proposed [14], as follows:

“Pleasure is a conscious experience, evolved to elicit or reinforce behaviors beneficial to an organism’s survival and/or reproduction. It is affectively and cognitively processed as a positive and dynamic sensation that can vary in intensity, duration, texture, spatial specificity, and anatomical location. Pleasure is characterized as ‘physical’ when primarily triggered by stimuli that are directly rewarding or enjoyable, and as ‘psychological’ when triggered by cognitive processes, memories, and emotional states. Depending on its intensity and duration, pleasure can override other adaptive instincts and motivational drives, leading to states of dependency and self-damage.”

Categories of Pleasure Intensity

In the Welfare Footprint Framework, pain intensity categories are operationally defined based on the assumption that more unpleasant sensations should be more disruptive, engaging a greater share of attention. [15,16]. This is rooted in the evolutionary expectation that the greater the threat, the more intense the signal should be to ensure it is prioritized over other functions and behaviors [17,18]. A similar approach can be used to define categories of pleasure intensity, with intensity categories defined based on the degree of engagement with positive experiences. First, the degree of engagement in experiences is likely to correspond to the hedonic value of these experiences [6]. A greater motivation to play, interact socially and explore is likely driven by a more intense positive experience. Second, the degree of motivation to engage in positive experiences is also likely to match their broader adaptive value [19]. Just as pain intensity often signals threat severity, pleasure intensity may correlate with the evolutionary importance of the activity, such as resource holding, learning, parental care, and mating (though maladaptive exceptions can be present, such as addiction in humans and feather-plucking in birds).

Similarly with the case of pain, here we propose the use of emphatic and universally recognized terms, focusing on concepts that reflect the degree of engagement with the pleasurable state. The definitions of pain intensities were first presented in a paper aimed at the medical audience [13], but designed to maintain their universality for non-human animals. This same broad approach is used to define pleasure intensities:

- **Satisfaction:** low-intensity positive states, where an individual shows subtle signs of comfort or satisfaction associated with a physical sensation or meeting a non-essential need. These might include comfortable bedding conditions, grooming or basking in the sun. Engagement is present but not overwhelming, allowing the individual to easily shift attention to other stimuli or activities as needed.

- **Joy:** positive states involving greater engagement in rewarding activities. Individuals may display enhanced vigor in play, stronger social bonding, or more or active engagement in highly preferred activities, such as foraging. Behaviors indicative of joy suggest a greater focus on these positive experiences, although they do not exclusively dominate the individual's attention. The individual's behavior is noticeably directed towards maintaining or enhancing the positive experience. Physiological indicators may include heightened autonomic responses (e.g., heart rate).
- **Euphoria:** experiences in this category are intense and the primary focus of attention. Everything else might seem secondary. Euphoria might be observed in immersive play, mating rituals, or the pursuit and enjoyment of highly favored resources, such as a successful hunt. In some situations, this intense state might lead to spontaneous expressions of pleasure, such as vocalizations.
- **Bliss:** At the peak of positive experiences, bliss represents a profound level of pleasure that pervades the individual's sensory and emotional experience. It's a sensation that transcends the ordinary. When experiencing bliss, the sensation of pleasure is so overwhelming that it eclipses other immediate needs or environmental stimuli for the duration of the experience. The world outside fades away as the individual is consumed by this all-encompassing state. Examples could be orgasmic states, reuniting with socially significant partners that are long missing, or the encounter of extremely positive conditions after prolonged periods of stress and hardship. Blissful states are expected to be rare and of short duration.

Just as we recently included the category 'no pain' as an additional intensity level (zero pain), it is also convenient, whenever relevant, to include the category 'no pleasure,' which represents the hypothesis that no positive affective states are experienced over the period of interest.

Pleasure-Tracks

The Pleasure-Track is a notation system analogous to the Pain-Track [13], where hypotheses on the temporal evolution and intensity of positive affective experiences are described. To this end, each experience is atomized into a level of analysis that is justifiable through empirical evidence. This is done by decomposing each experience into meaningful time segments, where each time segment is characterized by an expected intensity. Next, hypotheses about the intensity and duration of the experience at each of these segments can be informed by empirical evidence.

To illustrate the concept of a Pleasure-Track, we consider the hypothetical intensity and duration of play bouts in young calves, as follows: (Phase I) the play session begins with calves engaging in light play or exploration. This includes behaviors such as gently nudging or sniffing play objects, or light social interactions with other calves. The engagement is present but not overwhelming, allowing the calves to remain aware of their surroundings and easily shift their focus to other stimuli. As the play behavior escalates (Phase II), calves enter a state characterized by more vigorous activities such as running, jumping, and robust social play like head-butting or chasing. The calves show a clear focus on these rewarding activities, with their behavior directed towards maintaining or enhancing the experience. Physiological indicators might include increased heart rate or more expressive body language, reflecting their engagement in the play. The peak of the play experience (Phase III) is where the activity becomes the primary focus of the calves' attention, with calves fully immersed in play, displaying spontaneous expressions of pleasure such as vocalizations or exuberant body movements. After reaching the peak of excitement, the intensity of play begins to decrease. Calves may start to engage in less vigorous activities, such as slower running or gentle nudging, as they start to wind down from the high energy play. This stage (Phase IV) is characterized by a gradual reduction in the intensity of their actions and a shift towards more relaxed behaviors. When the play bout concludes (Phase V) calves often display behaviors indicative of relaxation. This may include lying down, social grooming, or simply resting in close proximity to their playmates. The Pleasure-Track below summarizes these hypothetical ethological observations for a group of calves. Average phase durations are also hypothetical, and in real scenarios are expected to vary with factors such as the species, age, space available, group size, climatic conditions, time of day, and hunger [20].

Pleasure-Track. Hypothesis on the evolution of pleasure intensity during one play bout among calves.

	Phase I (Exploration)	Phase II. (Escalation)	Phase III (Peak)	Phase IV (Resolution)	Phase V (Relaxation)
Bliss					
Euphoria		20%	60%	20%	
Joy	20%	60%	40%	40%	20%
Satisfaction	60%	20%		40%	80%
No pleasure	20%				
	10-30 sec	10-300 sec	5-40 sec	20-100 sec	2-10 min

As with the Pain-Track, the Pleasure-Track is designed to capture situations in which there is uncertainty in the classification of the intensity of pleasure. Therefore, probabilities are used to represent how likely it is that each category of pleasure intensity is experienced. Uncertainty (or natural variation) regarding how long each

Cumulative Pleasure (individual level)

(time estimates are the product of probabilities and duration in each segment as established in the Pleasure-Track)

	Phase I (Exploration)	Phase II (Escalation)	Phase III (Peak)	Phase IV (Resolution)	Phase V (Relaxation)	Cumulative Pleasure (per playing calf per bout)
Bliss						
Euphoria		5-57 sec	4-23 sec	4.7-19 sec		0.4-1.4 minutes
Joy	2.2-5.8 sec	15-70 sec	2.7-15 sec	9.4-39 sec	29-120 sec	1.8-5.0 minutes
Satisfaction	6.5-17 sec	5-57 sec		9.4-39 sec	210-460 sec	3.0-8.8 minutes

The assessment of Cumulative Pleasure for an individual over a certain period or even their lifetime, can be also established by determining the cumulative impact of all the positive events experienced. Similar to negative experiences, this is best represented as the sum of the time spent in positive states from all these events, whether they happen sequentially or simultaneously. This also includes events that happen repeatedly. For instance, if young calves play as described in the hypothetical scenario 1-8 times a day for 4 weeks, the Cumulative Pleasure for each calf would be a total of approximately 15-130 minutes of Euphoria, 1 to 7.3 hours of Joy, and 1.7 to 13.3 hours of Satisfaction. This is the of the estimates shown in the Pleasure-Track, daily frequency of playing bout and total number of days playing.

Of course, different positive experiences can interact with each other in various ways, both physically and psychologically. These effects, when potentially leading to changes in the outcomes, must be investigated on a case-by-case basis.

Cumulative Pleasure (population level)

Cumulative Pleasure can be also calculated at the population level. This requires accounting for differences in the exposure of population members to different positive experiences. This is achieved by weighting estimates by the prevalence of each experience, which enables determining the cumulative time in pleasure experienced by an average member of the population. For example, in the hypothetical scenario of play in calves, Cumulative Pleasure could be weighted by the proportion of the calf population playing in the period of interest. For instance, if 50-90% of the calves played over the period of two weeks, Cumulative Pleasure for the average population member over this period would be the product of this prevalence and Cumulative Pleasure for each individual over the two weeks (resulting in 15-130 minutes of Euphoria, 59-440 minutes of Joy and 100-800 minutes of satisfaction)

*Estimated time in pleasure, for the **average population member**, due to playing for a period of two weeks*
(time estimates are the product of Cumulative Pleasure estimates for each individual over 2 weeks and prevalence)

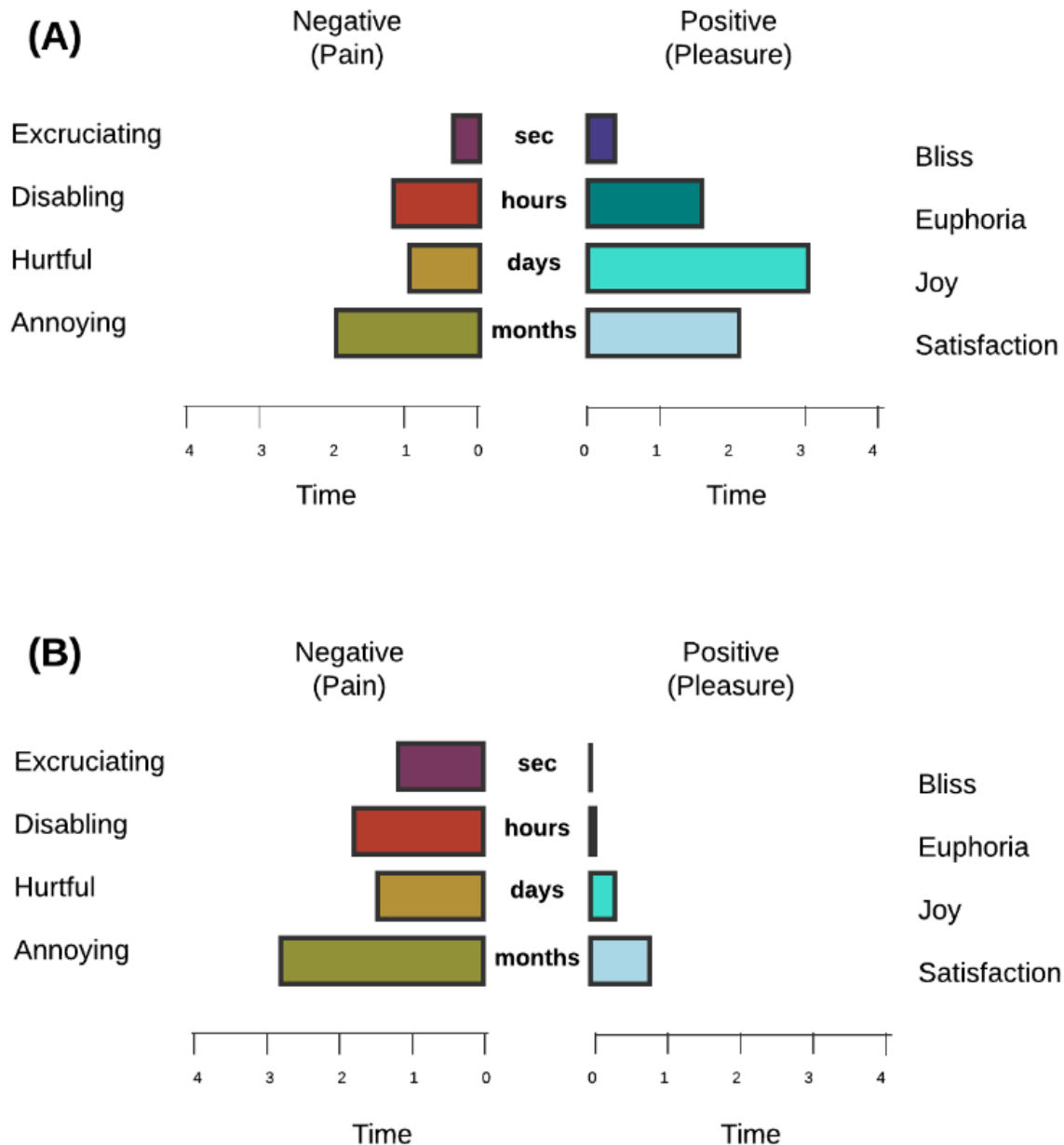
Cumulative Pleasure over two weeks (average population member)	
Bliss	
Euphoria	11-95 minutes
Joy	39-330 minutes
Satisfaction	67-570 minutes

As with estimates of time spent in pain, we don't combine the four categories of pleasure intensity into a single one. This is because, as thoroughly discussed for pain [21], there are no empirical references to establish a weighting system between the intensity categories, hence a single scale of pleasure.

A notation proposal for Welfare Footprints

By considering positive experiences, Welfare Footprints can be expressed as the time spent in negative and positive affective states of different intensities, i.e., Cumulative Pain and Cumulative Pleasure. To help visualize these effects, we propose to present Welfare Footprints as a double bar chart, as illustrated in the examples below. This graphical representation juxtaposes the time spent in negative affective states against the time spent in positive affective states, across various intensities. The figure illustrates two footprints, depicting the distribution of time spent by an individual (or

population, if the prevalence of different pains and pleasures are factored in the analysis) at each intensity of pain and pleasure (note that the quality of life depicted in the first Welfare Footprint [A] is clearly better than in the second [B]):



The time units used in the chart for each intensity category (seconds, hours, days, and months) are flexible and can be adjusted. However, because of this flexibility, it is crucial to always specify the units in the chart.

Because positive and negative intensities are displayed side by side, it is important to reiterate that no equivalence is implied. For instance, whether 10 seconds on the most

intense form of pleasure ('Bliss') can be considered a direct counterpart of 10 seconds under the most intense form of pain ('Excruciating') remains to be determined.

Further Thoughts

The welfare of sentient organisms is shaped by a complex interplay of positive and negative affective states [6,19,22]. While combining both positive and negative experiences would offer a fuller picture of their affective lives, there are many challenges to measure or compare these states ethically or quantitatively [5,23–27]. For example, Shriver [26] challenges the idea that pleasure and pain are just two ends of a continuum, pointing out that these states are driven by different cognitive processes, contribute differently to overall well-being, and have separate relationships with motivational systems. Considering these complexities, we do not attempt estimating how cumulative time in pain and pleasure might balance each other out. Instead, we focus on describing and measuring these affective states in a transparent and relatable way: by estimating time spent in states of pleasure and pain, at different levels of intensity.

We still maintain that negative states have a disproportionate impact on an individual's life and welfare. Pain, especially when severe, can prevent the possibility of positive experiences. However, positive experiences and states are valuable, especially when more intense sources of pain have already been mitigated. Therefore, Welfare Footprints must not overlook this aspect. This text is aimed at incorporating positive experiences into the Welfare Footprint framework. Welfare Footprints that focus solely on pain are already valuable (especially for addressing the extreme situations many captive animals face), but a more comprehensive approach that includes positive experiences can provide a richer assessment. This complete version of a Welfare Footprint can thus better guide animal welfare policies, inform advocacy groups, and enhance public awareness about the ethical implications of animal use.

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