Health-promoting factors and animal welfare

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Summary. - The notion of “health” as the absence of disease has been replaced by a more holistic view based on the concept of “total wellbeing” and its interrelated physiological, psychological, and social components. This approach has radically changed biomedical research, both in terms of experimental methodology and in addressing ethical issues such as animal welfare. The present work focuses on the entire range of factors that can affect the wellbeing of experimental animals, including the physical, social, and psychological conditions of the housing environment, and the animal’s behavioural and biological reaction to this environment.

Key words: social factors, environmental enrichment, animal experimenta)

Riassunto (Fattori di promozione della salute umana e del benessere animale). - Il concetto di salute è oggi riferito non più alla semplice assenza di malattia ma a una visione “olistica” della interazione funzionale tra fattori fisiologici e psicologici. L’enfasi si sta spostando dal trattamento alla prevenzione, ovvero agli effetti di promozione e di mantenimento della salute. La psicologia della salute studia i cosiddetti “health behaviours”, lo stile di vita, i comportamenti a rischio e le strategie di coping. Oltre che al campo della salute umana, il nuovo approccio si rivela prezioso per l’eticità della sperimentazione animale e per la qualità del dato. Si sono individuati alcuni importanti criteri comuni: il grado di controllo esercitato sull’ambiente e il ruolo supportivo giocato da alcuni tipi di arricchimento ambientale e/o sociale.

Parole chiave: socialità, arricchimento ambientale, sperimentazione animale.

Introduction

In the past several decades, the notion of “health” as the absence of disease or illness has been replaced by a more holistic view based on the concept of “total wellbeing” and its interrelated biological, physiological, psychological, and social components. Whereas the focus was previously placed on the individual, existing in a sort of vacuum where only the physical condition of the body was important, it is currently placed on the entire gamut of physical and psychosocial variables of the individual’s environment. In other words, the body has been reinserted into the multifaceted context in which it was born, has developed, and will die.

This approach has resulted in a radical change in the foundation on which biomedical research is based, and the focus has begun to shift from costs to benefits and from the negative correlates of physical, psychosocial, and ecological variables, to the positive correlates. Instead of searching for the causes of disease, attempts are being made to identify the factors that may prevent it. In particular, health psychology was created to evaluate the role of behaviour, attitudes, and beliefs in health [1]. Gochman [2] has extensively studied social, family, and cultural influences on health behaviours, specifically, lifestyle (e.g., eating and sleep habits), safety behaviours (e.g., physical exercise and teeth flossing), risk behaviours (e.g., smoking and drinking), and health-related cognition (e.g., beliefs, expectations, values, perceptions, and emotional states), and has also analysed the response to illness and care-seeking behaviours, which can be considered in the larger context of the evaluation of coping strategies. Cognitive, behavioural, and emotional strategies (i.e., those strategies that an organism adopts to exert some degree of control over life events and its reaction to them) have been shown to greatly mediate the impact of stressful events on both psychological and physiological health [3]. The intensity or quality of stressors cannot be assessed without considering the individual who experiences them, their context, and the supportive social network of that individual [4], and efforts are being made to understand the effects of
a number of conditions and experiences in terms of promoting, maintaining, and recovering good health.

In addition to its effects on human health, this approach has been increasingly beneficial to experimental methodology in all fields of research, including that on non-human species, and to resolving ethical issues, which generally arise where animal husbandry and experimentation are concerned. The major benefit to experimental methodology is that an accurate and thorough understanding of the given subject allows high quality data to be obtained. With regard to ethical issues, it can be said that, for once, science and ethics go hand in hand, in that a simple equation has at last been resolved: “happier” animals mean higher quality data. If an animal is maintained in a more natural, healthy, and stress-free environment, in terms of both physical and psychosocial conditions, then the results of the experimentation, whether they consist of biological material such as blood, tissue, and organs, or data on responses and behaviours, will not be confounded by the effects of abnormal levels of stress hormones.

Animal welfare

There exist a number of definitions of “animal welfare”, yet the notion itself has yet to be completely understood [5]. Although the quality of an animal’s life must be assessed using scientific criteria, subjective components such as ethical principles and value judgements are also involved, inevitably giving rise to the issue of anthropomorphisation [6]. One of the first definitions of “welfare” was provided in the 1965 report of the Brambell Committee, which takes into account both physical and psychological components, placing particular emphasis on the sensations and feelings of animals. The Committee introduced the concept of “the five freedoms”, a set of ethology-based principles which offer a logical and comprehensive framework in which to analyse the welfare of animals maintained in captivity: a) freedom from hunger, thirst, and malnutrition, maintained by providing easy access to fresh water and a proper diet; b) freedom from thermal and physical discomfort, maintained by providing an appropriate environment, including shelter and a comfortable resting area; c) freedom from injury and disease, through prevention and rapid diagnosis and treatment; d) freedom to express normal species-specific behaviour, by providing sufficient space, proper facilities, and the company of the same species; and e) freedom from fear and distress, by providing conditions and treatment that avoid mental suffering [7].

In 1985, the US Department of Agriculture issued an official act recommending that the welfare and psychological needs of captive non-human primates be taken into consideration and that special emphasis be placed on care practices and environmental conditions (see “Discussion” section in [8]). It has since been acknowledged that all vertebrate species can experience suffering and feelings of satisfaction and wellbeing and that these are related to both the physical and psychological status of the animal [9]. These considerations have been addressed in the recommendations for the use of animals in scientific and biomedical experimentation of European Directive 86/609/CEE and, in Italy, of Legislative Decree 116/92.

Although the notion of physical needs is generally clear enough, until recently, few efforts have been devoted to evaluating the more elusive, multifaceted concept of psychological needs (i.e., cognitive, emotional, and social needs) [8, 10]. Physical health and freedom from cruelty and abuse must obviously be guaranteed, yet animal welfare is also determined by the psychological state, which is heavily influenced by what the animal knows (i.e., cognition), perceives and feels, and by its motivations (e.g., hunger, thirst, and libido) [8]. In this perspective, subjective sensations play a key role: what the animal feels concerning the state of its own body, the way it perceives and interprets environmental stimuli, and its degree of awareness/consciousness of such sensations and perceptions, are all crucial components of its wellbeing [11, 12]. To this regard, Morton [13] has stated “an animal’s welfare is compromised when its physiological health and/or its psychological well-being, in relation to its cognitive capacity and life’s experience, are affected negatively”.

Both internal and external stimuli and environments can be, for example, aversive or rewarding to varying degrees, and the behavioural responses of adaptation, habituation, and coping, as well as physiological reactions (e.g., neuroendocrine or immunological ones), all contribute to the homeostatic maintenance of the internal state. The behaviour and reactions of animals are determined by a number of interacting phylogenetic and ontogenetic variables, including: individual characteristics (e.g., age, health status, and physiological and psychological conditions); genetics; previous experience and learning; the controllability and predictability of environmental conditions; and individual coping styles [8, 14].

From a holistic standpoint, it is evident that the interplay among biological, physiological, somatic, behavioural, and psychosocial aspects must be taken into consideration. Multiple assessments and an integrated approach, within the context of a biopsycso-social paradigm, can reveal how specific factors can affect an animal’s health status [15], as based on the theoretical and methodological contributions from different areas of research, such as
animal welfare has long been neglected. non-human primates and rodents, the social facet of research is conducted on social species, such as non-human primates and rodents, the social facet of animal welfare has long been neglected.

**Indexes and criteria**

According to Duncan and Fraser [6], there are three main approaches to evaluating animal welfare. One approach focuses on sensations and feelings, defining animal welfare in terms of subjective experiences and emotional states, in the attempt to promote the positive aspects (e.g., comfort and pleasure) and to reduce the negative ones (e.g., suffering and pain). A second approach is that of evaluating animal welfare based on normal or appropriate biological functioning (e.g., longevity, reproductive success, and physical health). The third approach stresses the need to allow captive animals to express, during development and consequently in adulthood, their natural behavioural repertoire as completely as possible.

However, these three approaches are not mutually exclusive and can be considered as complementary: general health status (e.g., external signs such as fur condition); performance (e.g., growth and longevity); immune and neuroendocrine functioning, behaviour, preferences, and motivations are all part of a single interacting matrix [8, 18]. Thus the assessment of animal welfare should be based on both clinical evaluations of physiological and biochemical indexes and ethological analysis of the different aspects of the behavioural repertoire.

For example, different levels of a given emotional state can be evaluated based on neurochemical and endocrine physiological indicators [8, 19], such as the neuroendocrine variables involved in activating sympathetic-adrenal-medullary, hypothalamus-pituitary-adrenal, and peptidergic systems, heart frequency, and metabolic alterations [17]. Changes in basal levels of glucocorticoids, for instance, can be useful in assessing the level of emotional activation, in that they represent a measurable yet sensitive index of the intensity of various psychological challenges posed to the animal [19].

As for behaviour, although recreating a perfect replica of the animal’s natural environment is quite difficult, very often the captive environment is conducive to only a very small portion of the animal’s natural behavioural repertoire. Although specific tests or challenges may be used to assess various behavioural parameters, the ethogram itself of each single species should be compiled on the basis of observations in the wild and then refined in the laboratory for use as a reference for welfare-related evaluations. By observing a number of basic species-specific and individual behaviours (e.g., general arousal/activation, posture, locomotion, vocalisations, and the intake of food and water), important information can be obtained on the state of the animal, which can provide insight into temperamental traits and coping strategies [6, 20]. By allowing animals to engage in complex and varied social interactions with conspecifics, such as fighting, affiliation, and play, increasingly subtle information can be obtained on feelings and emotional states. However, the lack of observable behavioural abnormalities is not necessarily indicative of a psychological and physiological equilibrium [8].

**Health and environment**

Biochemical, physiological, and behavioural changes are often the result of the animal’s environment, and the laboratory can provide too much or too little stimulation. This environment consists of a physical component (e.g., the cage and the objects inside it), a nutritional/sensorial component, a psychological component (e.g., the possibility to exert some degree of control over events and their predictability), and a social component (e.g., interaction with other animals of the same or different species, including human beings; hierarchical structure, and social status) [21, 22], all of which can be quantitatively and qualitatively controlled by providing appropriate housing conditions [8, 22].

When conducting behavioural experiments, it must be considered that the characteristics of the cages in which the animals live and of the environment in general may not allow the animal to express the complex species-specific repertoire of social behaviour, which, from an ontogenetic standpoint, can be considered as the basis for acquiring fundamental behavioural skills and individual coping strategies. For example, in rodents, the presence of conspecifics in the cage has various beneficial effects, such as that of preventing the animals from developing stereotyped behaviours (i.e., repetitive sequences of fixed motor patterns with no apparent immediate purpose and performed out of context) and from becoming irritable, which can result from excessive environmental stimulation [23]. In addition to providing an appropriate social environment, stereotypes can also be greatly reduced or even eliminated through changes such as increasing the available space [8, 24]. As discussed in depth in the following section, a rich and
complex social environment, including cagemates of
different age, gender, and characteristics, allows the
animals to engage in varied and dynamic interactions
which represent the basis for the development of
adaptive behaviour.

From an ontogenetic standpoint, the environment
in which an animal lives is fundamental. For instance,
in rodents, the modification and diversification of both
behaviour and neural anatomy have been shown to be
associated with having lived in a physically and
socially complex environment from weaning to the
juvenile stage [25-27]. The experimental manipulation
of the early social environment also markedly affects
the sensitivity and efficiency of different
neuroendocrine systems mediating the response to
external stimuli, although additional research is needed
to clarify the underlying mechanisms [21].

Some findings from the literature on rodents

If a basic degree of welfare is to be ensured, then
the given species’ evolutionary history, natural
environment, social structure, and behavioural
repertoire must be adequately taken into consideration,
which entails providing the animal with a certain level
of physical and social complexity. As mentioned
above, to this end the physical and social features of
housing can be enriched. For example, larger cages
containing fixed or movable objects (e.g., partitions,
shells, stairs, shelters, running-wheels, nest-boxes,
tubes, and pellets) allow the animals to manipulate
their environment and thus to exert at least some
degree of control over it and their own functioning and
to express a greater range of their behavioural
repertoire (e.g., moving, hiding, hoarding, playing, and
regulating functions such as staying separated from
others). The environment’s physical features also
contribute to allowing for more complex and natural-
like social interactions; for instance, a simple partition
can be used to better regulate social proximity, to
delimit sub-territories, to choose the extent of visual
control over the other animals, and to hide. In turn, the
expression of complex social interactions such as play
behaviour in juveniles can contribute to a more
extensive and complex use of the physical
environment. With regard to the social environment, a
variety of facets must be considered, such as the
number of individuals, their gender, familiarity, and
social status.

The physical and social enrichment of housing can
also block or reverse, from both a behavioural and
physiological standpoint, the negative effects of a
range of genetic defects (e.g., behavioural deficits of
Lurker mutant mice) [28] and early insults (e.g.,
neonatal anoxia, experimental damage to certain
regions of the brain, and exposure to behavioural

teratogenic agents) [29-32]. From a learning-related
standpoint, even ageing seems to be contrasted by
enriched housing conditions and motivation-sustained
physical and mental exercise, through increased
sensorimotor stimulation and the endogenously
generated plasticity [33, 34].

With specific regard to the physical environment,
in rats, enrichment has been associated with reduced
reactivity to stressful events, such as exposure to the
species-specific and natural stimulus represented by
the odour of a predator (e.g., cat urine) [35].

Neural/functional modifications have also been
reported, such as increased neurogenesis [27, 36, 37],
immunocompetence [38], and production of
neurotrophines such as NGF and BDNF [39].

Moreover, the possibility to increase spontaneous
physical exercise has been found to exert a series of
beneficial neuroregulatory effects [27]. An enriched
physical environment has also been reported to have
significant effects on sleep patterns in juvenile rats
[40] and to increase the expression of positive
behaviours such as social play [41].

With regard to the social environment, this is an
important issue which needs to be more thoroughly
addressed. Compared to socially isolated animals,
socially housed rodents and non-human primates have
shown a reduced immunological, behavioural, and
adrenocortical reaction to a number of stressful
situations or aversive stimuli, including maternal
separation [42], environmental novelty [43, 44],
exposure to a live snake or a snake-like object [45],
and social defeat [46]. On the other hand,
overcrowding is associated with a reduced adaptability
to stressful stimuli, enhanced basal corticosterone
levels, and thymus atrophy [47, 48].

Along with social isolation, sexual segregation
during development has been found to produce
specific alterations. When pups or juveniles are kept in
groups of the same sex and age, the lack of social
interactions with conspecifics of the opposite sex
affects the daily functional activation of the major
systems of physiological regulation. The gender
composition of litters has been shown to have both
short- and long-term effects on behavioural responses
and on the physiological parameters related to gonadic
hormones and the activity of the HPA (hypothalamic-
pituitary-adrenal) axis [49]. The underlying
mechanisms appear to work both directly, by means of
intra-litter interactions (i.e., among pups), and via the
mediation of alterations in dams’ caring behaviour [50,
51]. The same manipulation of early social milieu has
been found to regulate the function of endogenous
pain-relieving systems modulated by opiates [52] and
benzodiazepine agents [53]. Moreover, subtle, ongoing
factors, such as the familiarity [54-56], quality, and

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stability of social relationships, as well as the social structure and the hierarchical position of the individual, can contribute to regulating behavioural, neuroendocrine, and neuroimmune functions [21, 57].

**Final remarks**

Based on the results of research on animal welfare, some sound inferences and judgements can be made concerning both the quality and intensity of the sensations and feelings of animals. As highlighted by Dawkins [58]: “As a non-invasive and non-intrusive tool, behaviour has great advantages. As the 'final common path' of physiological state, it gives a direct read-out of an animal’s emotional state. If properly validated against other measures, it has the potential to become widely used in the in situ measurement of animal welfare - that is, in the assessment of welfare in the places where it really matters - on farms, in zoos and in laboratories”. In particular, since laboratory rodents are specifically kept for research purposes, housing should consist of an environment that both provides valid data and avoids causing unnecessary suffering to the animals [59]. Such an environment should even promote the animals’ wellbeing. To this regard, at least some basic physical and social enrichments (i.e., those that have proven to be beneficial to a particular species) should be considered as basic essential requirements, as opposed to optional ones.

The counterpart to this “ecology of health promotion” [60] can be found in the growing literature on humans, in which lifestyle, safety behaviours, and the availability of social and emotional support are placed in relation to neuroendocrine and neuroimmune functions and the individual’s health. In fact, there exists some important common ground in animal and human research, such as the degree of control that the individual is able to exert on its environment and life events and the potential buffering or supporting role played by the social environment and interactions. Thus studies conducted in the two apparently unrelated fields of animal welfare and the promotion of human health may, together, contribute to providing unique theoretical and methodological insight.

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