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Commentary

Ethogram of the Domestic Cat

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Abstract: The existing domestic cat literature predominantly contains lists detailing its behaviour. However, these lists are neither specific enough for domestic cats nor general enough for all behaviours on a macro level of the domestic cat. Furthermore, the majority of studies lack illustrations. Therefore, we have developed a comprehensive ethogram of the domestic cat and scalable schematic representations of the behaviour units. We evaluated observational data from free-roaming cats and cats from private households using ad libitum and focal animal sampling (video material 55.31 h, n = 170 animals). In addition, we used the leading literature and detailed anatomical studies to create systematic categories and morphologically correct drawings. A total of 117 discrete behaviours were recorded and divided into 12 categories. The description of each behaviour includes a name, a word definition, an ethological classification and a schematic illustration (excluding the category devoted to vocalisations). An ethogram is needed to better understand the behavioural repertoire of healthy domestic cats and to facilitate the design phase of further investigations. This document can help to better distinguish species-appropriate behaviours and body postures from those behaviours and poses that indicate chronic pain, stress or discomfort.

Keywords: behaviour; cats; ethogram; welfare; illustrations

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1. Introduction

In Canada, Japan, Russia and parts of Western Europe, the cat is the most common animal in human care [1–4]. Most domestic cats live together with humans—some have reverted to living independently from humans—and the relationship between the two species has matured over the last few centuries [5]. Although science has gained a lot of knowledge about the interaction between humans and other animals in the last few decades, there are still many unanswered questions about the relationship between cats and humans, as well as an insufficiently precise description of welfare and pain in cats [6–12]. Behavioural research devoted to domestic cats aims to better describe this special relationship, the resulting behaviour and the consequences for husbandry and clinical research to identify possible indications of suffering and disease when behaviour deviates.

In order to study animal behaviour, researchers and veterinarians need clearly defined and thus delimitable behaviours. Knowing the animal's behaviour is essential for the best possible husbandry. Any behavioural research begins by defining the behaviour under investigation in the context of the research question. Here, standardisation, categorisation and objectivity are crucial for the quality of the subsequent data and for better comparability. By breaking down the behavioural flow into small units within an ethogram, behaviour can be described, measured and compared against other behaviours for better data recording in a scientific context [13–17].

For domestic cats, however, there is no illustrated and nearly complete ethogram. Consequently, many researchers in the past have developed their own specialized partial behavioural catalogue relevant to the context being explored [6,18–34].

The lack of a comprehensive ethogram for domestic cats that addresses the entire spectrum rather than just partial aspects of the behavioural repertoire complicates several issues related to animal welfare, particularly in the areas of behavioural detection, care and protection; without a standardised inventory, an appropriate assessment of stress and suffering in relation to defined behaviours in a healthy animal cannot be made.

Furthermore, discrepancies in the interpretation of their behaviour may arise. Animal welfare organisations, breeders and animal shelters need clear and valid guidelines to help them understand how cats react in certain environments and what their needs are. A standardised ethogram can help to better understand the needs of cats, to respond to stress or discomfort and to ensure a higher level of animal welfare. We therefore consider the ethogram to be an important tool for conducting a welfare assessment. The diagnosis of behavioural problems without a universal ethogram, such as spraying or stereotypic behaviour, is inconsistent and subjective. Different veterinarians, animal trainers or researchers may interpret behaviours differently, leading to incorrect treatment or evaluation. This could result in incorrect decisions regarding care or even the unnecessary disposal of the animals. A better understanding of cats' needs and avoiding misinterpretation will directly benefit their welfare.

We have synthesized the existing literature and its knowledge on domestic cat behaviour including several behavioural catalogues which deal with a limited number of contexts, e.g., litter box use or marking. There is also a proposal for a standard ethogram for the whole Felidae family, which maps all behaviours of feline species in a generic list, from Stanton et al. [35] (2015), as well as the work from the UK Cat Behaviour Working Group [36] (1995) that proposed morphological state descriptions for 22 behaviours but has not been published in a peer-reviewed journal. Lastly, there is the work of Leyhausen [37] (1974), who has dealt intensively with the predatory and social behaviour of domestic cats. He also made illustrations of several sequences of behaviour.

To our knowledge, there is no published ethogram of a broad spectrum of behaviour patterns specific to the domestic cat with a mapping of all macro-behaviours onto detailed visualisations. As a result, many relevant details are lost. With this study, we aim to fill this gap by proposing a comprehensive ethogram with additional schematic representations.

We assume that by observing the behaviour of domestic cats, we can quickly identify deviations from the healthy standard repertoire. This ability will in turn facilitate the evaluation of well-being. Finally, we assume that the use of this ethogram will save researchers time and effort in creating behavioural definitions for their studies, while helping to standardise behavioural research in felids. We have placed great emphasis on the user-friendliness of the ethogram. Schematic drawings are more memorable than written descriptions only and facilitate quick recognition of the behaviours in practice. We expect that this will make possible quick familiarisation with various cat behaviours, which may prove very useful for observations made during field research and for evaluating video recordings of cat behaviour. From an animal welfare evaluation perspective, this list can be a decisive tool for detecting early signs of suboptimal husbandry practices or early forms of diseases. In addition, both the attachment system between the cat and human caregiver and the way the cat is kept have a great influence on the well-being of the cat. Thus, the present ethogram forms the basis for accurate investigation of the attachment and housing system of the domestic cat.

2. Procedure

2.1. Sampling Procedure

The video material of the original observations used for this work was collected by the first author (I.K.) and the students of the research group over a period of six years from July 2017 to July 2023. The video recordings of free-roaming cats and cats from private households took place in Fulda in northern Hesse, Jena in Thuringia, Nuremberg in northern Bavaria, Osnabrück in southwestern Lower Saxony, and in the greater Berlin area in north-

eastern Germany. The video material examined amounts to 55.31 h. A total of 170 animals were observed (see research group and cat data in the Supplementary Materials).

First, the behavioural categories were defined. We follow the labels proposed by Tembrock [38] (1982) for object-oriented studies translated into English (further information on the categorisation process can be found in the Supplementary Materials).

The video material was first viewed using the ad libitum method to define the main behavioural states and assign them to the defined categories. With ad libitum sampling, there is no systematic approach to what is observed at what point in time. An obvious limitation of this method is the risk of bias in favour of individuals that tend to stay in the background or move inconspicuously. In the case of this study, ad libitum was useful to gain a rough overview during pre-observation or to record rare events such as 'giving birth' [14–16]. After the categories and primary states (e.g., eat, sleep, locomotion, social behaviour) were determined, the entire video material was evaluated using focal animal sampling to describe the behavioural units. In focal animal sampling, the entire behaviour of an individual is observed over a fixed period. The behavioural units that occur are noted in the protocol with an abbreviation. The resulting focus protocol reflects the entire behavioural stream in a given time. Ideally, the order of the individuals in a group is determined before the observation, as we did here. Focal sampling is suitable in this case, where the entire behavioural repertoire has to be monitored [15,16]. One limitation of the method is that the focus animal is not in the observer's sight for long periods of time. The risk of bias exists because many animals value their privacy when eating or mating. Consequently, these behaviours are under-represented. To counteract this effect, we recorded a large amount of material and changed the focus animals at short intervals of 1 min. If videos contained only one animal, it stayed in focus for the entire video. When the animal was out of sight, we stopped the timer for that animal. A standardised focus protocol in Excel was used for this (see Supplementary Materials).

To ensure that all persons involved in the data collection process collected reliable data, a validation test was carried out. For this purpose, video examples were analysed by the first author and by the students, and the results were compared. In the event of discrepancies in the protocols, the topics were discussed until everyone agreed on the appropriate behaviour. The test was repeated with a new sample until the protocols of the observed persons showed less than 5% deviation.

After the data had been collected, the protocols were examined for 'new' behaviours. They were then assigned to a category and listed. All behaviours in the inventory were observed in the data. One exception was the behavioural complex 'giving birth' as well as 'mating behaviour' and the corresponding vocalisations. We specifically requested video material for these behaviours within the group of animal shelters and cat owners recruited within the network. The data were observed and described ad libitum.

2.2. Creating Schematic Drawings

When a new behaviour was identified, it was defined, described and then illustrated by abstracting the frozen image from the video sequence. The drawings and the style of schematisation are adapted from the preliminary work of Leyhausen [37] (1974) and the UK Cat Behaviour Working Group [36] (1995). The focus was on correctly depicting the postures of the body parts including the head, pupils, whiskers, ears and tail. For the sake of clarity, we have refrained from using micro-expressions of the face (see Supplementary Materials for software information).

2.3. Literature Review

A systematic search of the existing literature was carried out in common academic databases (Science Direct, Springer Link, Web of Science, Wiley Online Library, Elsevier) and in Google Scholar using the keywords 'ethogram domestic cat' and 'ethogram felis catus'. Of the 4160 individual studies initially identified, 20 were retained for their relevance (see Supplementary Materials for literature analysis). These were used for a

critical evaluation and data extraction. The listed behaviours from the ethogram were compared with definitions and designations from the literature. The resulting inventory is now proposed as a comprehensive ethogram for domestic cats.

2.4. Collaborative Review

A preliminary draft of the developed ethogram including schematic drawings was sent to various experts for critical review, including a native English speaker (S.H.). Disagreements regarding context and wording were resolved through discussion until consensus was reached. The preliminary version of the ethogram was finalized by the first author (I.K.) and validated by the fourth author (S.H.) and the research group leader (U.G.).

2.5. Ethical Review

Ethical review and approval were waived for this study because it involved non-invasive observations or video analyses of cats in their natural environment, causing no stress to the animals. Both the cats in private households and the cats living in the wild were not interrupted or disturbed in their behaviour. All animals are treated anonymously. In addition, the pet owners in private households consented to the video recording and agreed to participate in the study with their cats. Since the data were not collected for humans, but only for cats, ethical approval is not required under German law (DSGVO).

3. Ethogram

This work represents the first published visual ethogram for domestic cats and will hopefully demonstrate the enhanced efficacy of this format compared to purely written descriptions. Furthermore, it is noteworthy that the ethogram incorporates video and audio components for the category of vocalisations in the Supplementary Materials. The resulting list of behaviours for domestic cats, which represents a species-specific behavioural repertoire of healthy cats, comprises a total of 117 specific behaviours divided into 12 functional categories. The following labels were used to denote the functional categories: "Body postures" (Table 1), "General forms of movement" (Table 2), "Orientation" (Table 3), "Food acquisition and digestion" (Table 4), "Rest and sleep" (Table 5), "Protection and defence (incl. territorial advertising)" (Table 6), "Comfort behaviour" (Table 7), "Biosocial behaviour (intraspecies/interspecies)" (Table 8), "Play and learning behaviour" (Table 9), "Reproductive behaviour" (Table 10), "Mother–kitten interactions" (Table 11) and "Vocalisation" (Table 12).

Each behaviour contains a name that is believed to be commonly used in English, a written definition and a schematic representation (with an exception for vocalisations). As some behaviours have slight variations in form (e.g., gaits), the drawings contain sequences of one to three individual movement sections. We would like to point out that schematic drawings always contain a degree of generalisation and cannot depict all variants and intensities of behaviour.

Each behaviour has additionally been categorised into the classical ethological dimensions as a state (S) or event (E). An event may occur several times in a short period of time in an animal's behavioural sequence, while a state often occurs less frequently but over a longer period. This classic ethnological feature is important for the choice of suitable observation methods and study design. This assessment was made according to the methods explained in Martin and Bateson [16] (2007). Compared to previous works, we have either newly described or provided additional detail to the following behaviours: trot, rest and sleep, food acquisition and digestion, the complex of 'birth' and mother–young animal behaviour. We have included the category of vocalisations, focusing primarily on those related to social behaviour, recognition of well-being and stress or suffering, and species-specific communication. Here, too, we have captured a broad spectrum from the data (and provide video material in the Supplementary Materials).

4. Comments

In [37] 1974, Leyhausen focused his attention mainly on social and predatory behaviour, describing them in detail and illustrating some of them. The UK Cat Behaviour Working Group [36] (1995) has also included illustrations for some behaviours. In this paper, we broaden the focus and illustrate domestic cats interacting with individuals and performing their species-specific behaviours, as described in the Fourth Freedom of the Five Freedom model of animal welfare [39–43]. An ethogram serves as a valuable tool in ensuring that animal care and treatment are in line with the concept of animal centricity by focusing on the actual behaviour of animals, helping to tailor their housing and care to their individual requirements.

Human–cat attachment and housing systems have a great influence on the welfare of cats [44–46]. But little research has been conducted on the attachment and bonding behaviour regarding human keepers and caretakers in shelters [10,47,48]. In the future, our present work will fill the knowledge gap that begins at the conceptual phase of an ethological study by setting a firm basis of defined behaviour units to focus on. In addition, this work helps to compare and evaluate behavioural studies.

The citizen science approach is often discussed in the context of animal observation. Lastly, ethograms can also be a very important tool for these laypeople, e.g., as information displays in shelters or at the veterinarian where behavioural observations are described for caretakers. It thus also makes an important contribution to science communication, especially as it includes a visual component.

5. Conclusions

We believe that this ethogram provides a broad catalogue of behaviours which can be used as a reference to evaluate welfare in cats, both for general husbandry and for ethological and clinical veterinary assessments. Hopefully, it will also prove useful for the future development or refinement of welfare scales. Future work can supplement this work with further qualitative descriptions and illustrations of behaviours. In addition, we recommend subsequent quantitative processing of these behaviours, for example using Markov analyses and transition matrices, to see whether the distribution of behaviours is systematic and functionally coupled, thus underpinning the basis of the qualitative work.

Table 1. Body postures.

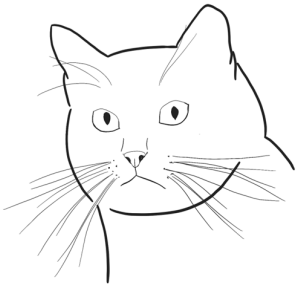
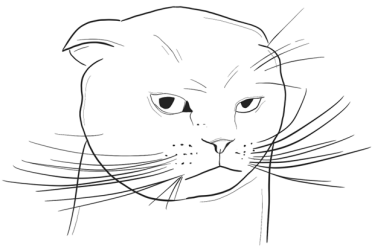
	*1. Ears in rest position (EIR)(S)* The cat's ears are in a neutral position: erect, pointing forward or slightly to the side. The cat holds its head upright. Its eyes are open. Its ears are directed backwards and may be set at an angle or slightly flat. Its whiskers are stretched out or in a neutral position.
	*2. Ears to back (ETB)(S)* The cat's ears are pointed backwards and may be slightly flat or curved. The cat holds its head upright, or its neck may be bent. Its eyes are open or narrowed to slits.

Table 1. *Cont.*

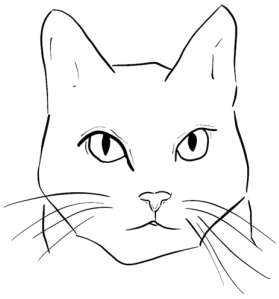
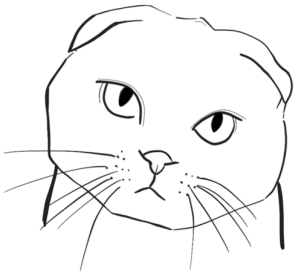
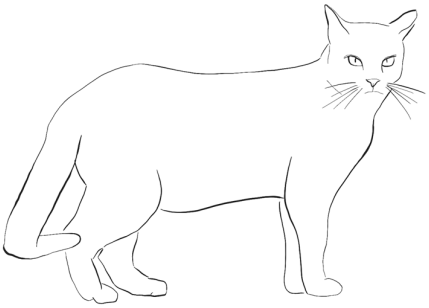
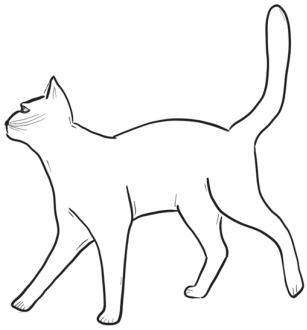
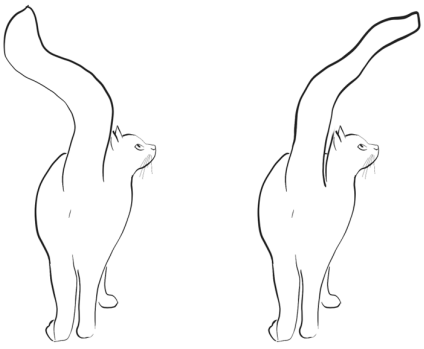
	*3. Ears forward (EFW)(S)* The cat's ears are tense and directed forward. Its eyes are wide open and alert. Its whiskers are erect.
	*4. Ears flat (EFL)(S)* The cat's ears are laid flat, with the tips of its ears either in extension of the axis of its head or pointing backwards/downwards. Its eyes are narrowed to slits. Its mouth may be open or closed. Its whiskers are erect.
	*5. Tail in rest position (TIR)(S)* The cat stands or walks. Its tail is stretched out in a neutral, non-strained posture with extension of the back or is curved down.
	*6. Tail up (TAU)(S)* The cat walks. Its tail is held up vertically, loosely and is not cocked. This may occur when the cat is approaching, following, walking away from or running after another cat or a human.
	*7. Tail whipping (TWH)(E)* The cat stands or walks. The whole tail is moving quickly from one side to another in a slow to intense whipping movement.

Table 1. *Cont.*

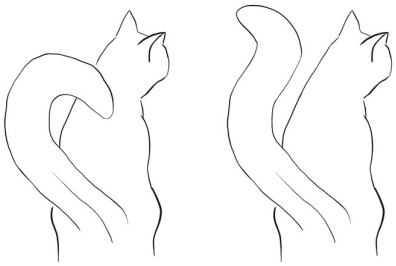
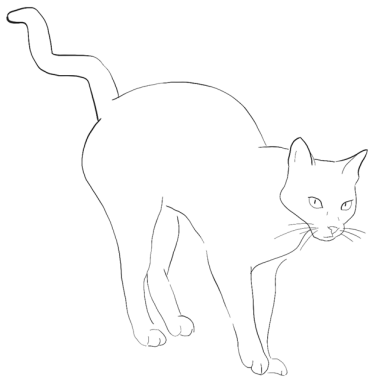
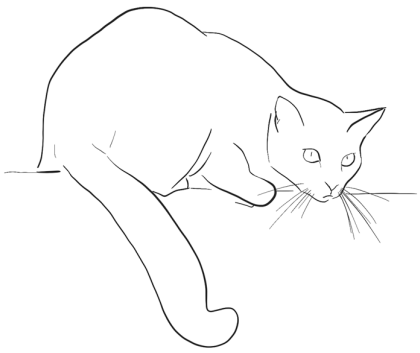
	*8. Tail twitching (TTW)(E)* The cat stands or walks. Either the whole tail or a part of the tail shows very rapid and abrupt movements (from side to side or up and down).
	*9. Tail slapping (TSL)(E)* The cat sits or squats. Its tail slaps quickly on the floor or against objects, such as furniture.
	*10. Tail quiver (TVI)(E)* The cat stands or walks. It vibrates its tail while lifting it vertically. This behaviour may be displayed, e.g., during urine marking.
	*11. Neck downwards (NED)(S)* The cat sits or squats, stands or walks towards something. Its neck is bent downwards. Its head is either brought in line with its back or tilted to one side. This behaviour may occur when the cat is moving towards another cat or observing a moving object.

Table 1. *Cont.*

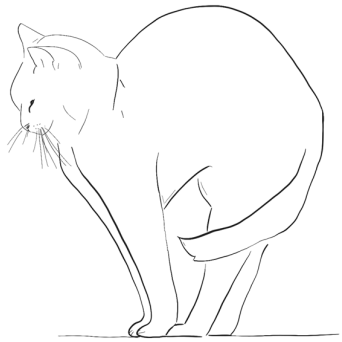
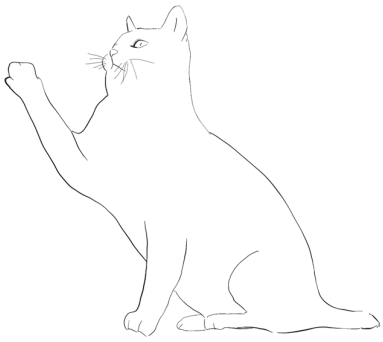
	*12. Cat hunchback (CAH)(E)* The cat sits or squats. It then stands up, curves its back upwards and stretches its legs. Its tail is usually also stretched out or curved around its body, and the fur may be erect on both its tail and its back. This may occur, e.g., after a period of rest. See Table 7.8 Cat hunchback (CHB)(E).
	*13. Raise paw (RPA)(E)* The cat sits and lifts one of its front paws. This situation may occur after examining an object on the floor or after the cat has encountered another cat or a human.

Table 2. General forms of movement.

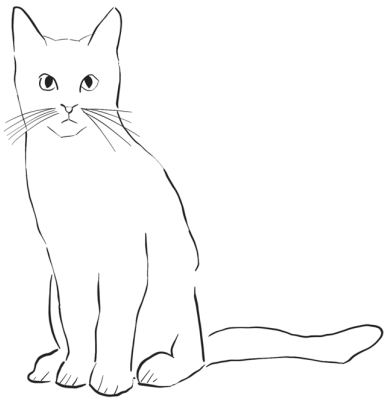
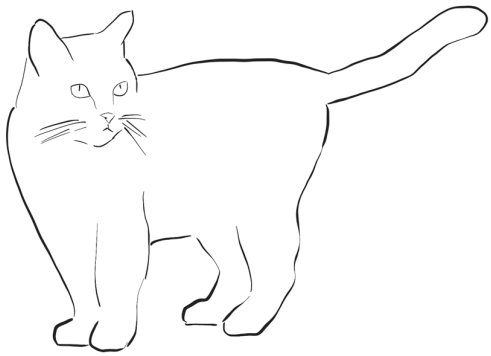
	*1. Sit (SIT)(S)* The cat sits with the hind part of its body completely on the ground. Its front paws touch the ground, and its front legs are fully stretched upward. See Table 5.1 Sit (SIT)(S).
	*2. Stand (STA)(S)* The cat stands with all four paws on the ground, legs loosely extended but flexible. Its head is upright.

Table 2. *Cont.*

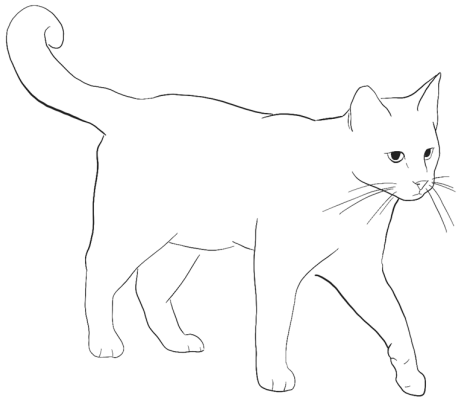
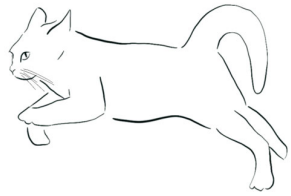
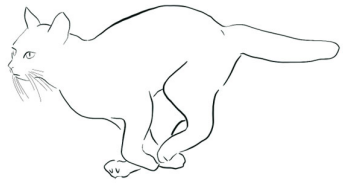
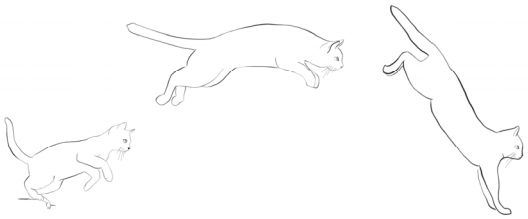
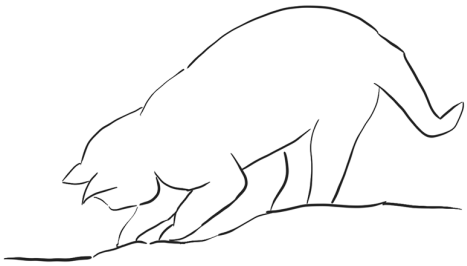
	*3. Walk (WAL)(S)* The cat walks in step, which is a four-beat gait. The cat moves its four legs one after the other. Usually, the diagonal pairs of legs are placed one after the other and there is no simultaneous stepping of two or more paws. While stepping, the cat always has at least two, and at most three, paws on the ground. Its head is raised, and its ears are relaxed or directed towards a source of sound. Walking is the slowest gait, with running (trotting and galloping) being faster.
	*4. Trot (TRO)(S)* When trotting, the cat moves in a two-beat gait. Two legs are always raised and lowered at the same time. The trot is a diagonal gait in which the front and hind leg diagonally opposite each other are moving alternately. The trot is faster than the walk.
	*5. Gallop/run (RUN)(S)* When galloping, the cat moves in a three-beat gait. Here, the cat has first one paw, then two paws, then three paws and finally no paws at all on the ground. This sequence may differ by gallop version. The gallop is faster than the trot.
	*6. Jump (JUM)(E)* The cat lifts off the ground first with its two front legs, then with its two hind legs. The momentum comes mainly from its hind legs. It lands with its front legs or all four legs on a surface or object.
	*7. Dig (DIG)(S)* The cat stands with its hind legs on the ground while digging a hole in the substrate with its front legs. The movement consists of dipping its front paws into the substrate and a steady pulling motion that moves soil/sand from the substrate backwards between its hind legs. The excavated substrate piles up behind the cat.

Table 2. *Cont.*

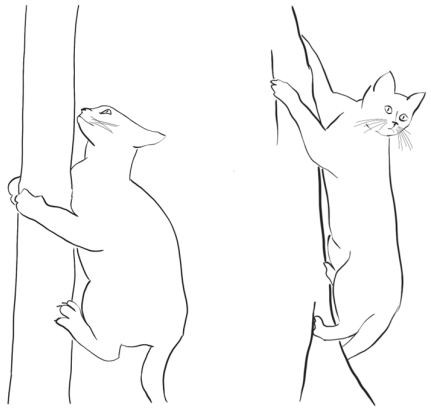
	*8. Climb up/down (CLI)(S)* The cat pulls itself up trees or other objects with its front and hind legs alternating. Both front paws are struck against the object at the same time with the help of the claws. Its body is pulled up until its hind legs also pull upward and then are struck against the object, with the claws also extended. Then, this process is repeated. The cat climbs down the tree or other object in the same way, rump first. This time its hind legs set the pace.

Table 3. Orientation.

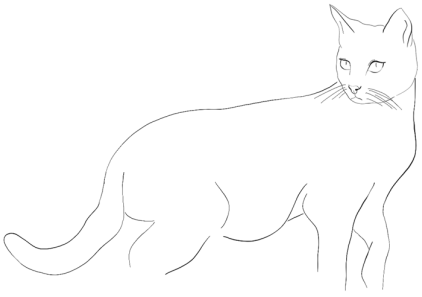
	*1. Observe/watch (OBS)(S)* The cat observes a moving or stationary object, another animal or a human. The cat is alert, its eyes are open and the third eyelid covers parts of the eye. Its eyes may track the target. Its ears are pointed and oriented in the direction of the stimulus source.
	*2. Fixate (FIX)(S)* The cat fixes its eyes on another animal, a human or an object that is moving. Its head is directed towards the target, its eyes are fixed more in place than when observing and the pupils are constricted to slits (during the day). The cat does not move.
	*3. Stare (STA)(S)* The cat fixes its eyes on another animal, a human or an object that is moving. The cat is not easily distracted by other activities in its environment. The cat's head is focused on the target, its eyes are wide open and look completely frozen, and the entire sclera is visible. The pupils are constricted to slits and do not move. The cat does not move. This may occur just before a fight against a rival at a territorial border.

Table 3. *Cont.*

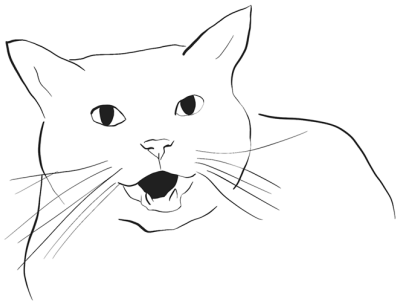
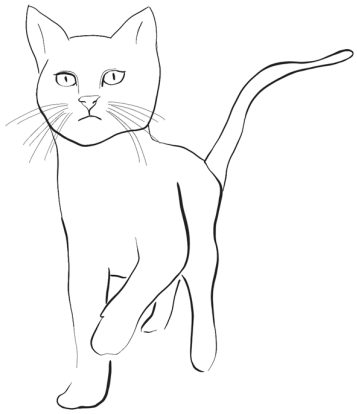
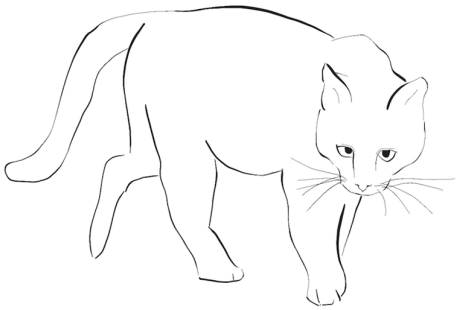
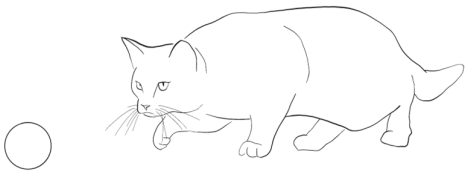
	*4. Smell/sniff (SME)(E)* The cat holds its nose in the air, in the direction of an object or another animal or human. While doing so, the cat inhales air through its nostrils, which thereby widen and narrow. This may occur in the context of general orientation, foraging or finding and selecting a mate in the mating season or detecting predators.
	*5. Flehmen (FLE)(E)* The cat opens and closes its mouth in a fast rhythmic movement to carry scents from the air to the roof of its mouth. It may also extend its tongue in the process. This behaviour, also known as flehming, usually occurs in the context of mating behaviour [49,50]. See Table 7.5 Flehmen (FLE)(E) and Table 10.1 Flehmen (FLE)(E).
	*6. Explore (EXP)(S)* The cat explores the environment, walking slowly. Its head is raised or temporarily touching the ground when sniffing or looking more closely at objects. The cat's eyes and ears are alert, responding to new stimuli.
	*7. Patrol (PAT)(S)* The cat walks briskly along, e.g., a territorial boundary such as the garden fence. The cat stops at regular intervals, sniffs objects and observes other animals or humans and sometimes marks territories by urinating and rubbing its cheeks at boundaries. Patrolling, usually by male cats, may be accompanied by meowing and trilling sounds.
	*8. Approach an object (APO)(E)* The cat approaches an object. Its head is upright, and its ears are pointed forward. Its neck and tail may be bent, and its eyes may be open.

Table 3. *Cont.*

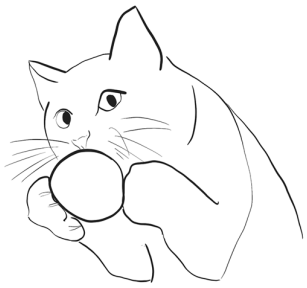
	*9. Grab/hold (GRA)(E)* The cat grabs an object or body part of another individual between its front paws in order to hold it. Its claws are usually retracted in the process. The cat may also grasp pieces of food in this way and eat, chew on toys, or hold and groom a kitten or a body part of another animal or a human.

Table 4. Food acquisition and digestion.

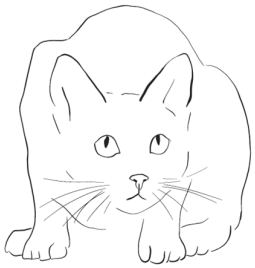
	*1. Salivate (SAL)(E)* The cat produces a lot of saliva, which sometimes runs out of its open or closed mouth. Some cats actively open and close their mouth in a gaping movement.
	*2. Stalk/pounce (STA)(S)* The cat's body is strongly pressed towards the ground. The cat is crouching and moves forward through, e.g., tall grass, a bush or an open field. It simultaneously watches, e.g., potential prey animals. The cat actively and quietly sneaks up on the target by attacking or jumping on it. This may occur in a hunting context or for protection and defence against enemies. See Table 6.7 Stalk/pounce (STA)(S) (STA)(S).
	*3. Crouch (CRO)(S)* The cat is crouching. Its body is pressed to the ground and all four legs touch the ground. Its tail may twitch. Its head is also close to the ground, and its neck is outstretched. Its eyes are fixated on an object or another animal, with the pupils mostly wide open. This posture usually occurs in the context of ambushing prey. See Table 6.8 Crouch (CRO)(S).
	*4. Tipple (TIP)(E)* The cat squats and watches, e.g., prey animals. After the cat actively and quietly sneaks up on the target, the cat quickly tipples with its front and hind paws while crouching low to the ground. This is usually immediately followed by attacking or jumping on the prey. This may occur in the context of hunting. See Table 6.9 Tipple (TIP)(E).

Table 4. *Cont.*

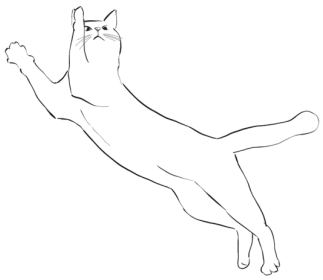
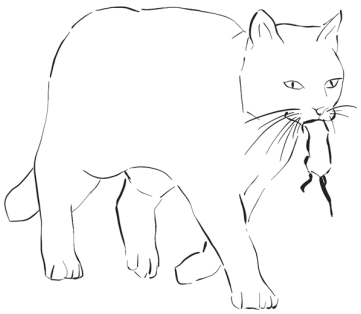
	*5. Prey jump (PRJ)(E)* The cat jumps with outstretched front legs and lands on a prey animal or a moving object. Its back may be either completely round or stretched out, depending on whether the target is far away or directly next to the cat and can be dived at from above or from the side. The jump can also occur sideways.
	*6. Bite (BIT)(E)* The cat sinks its teeth into a prey animal, an object, another animal or a human. Usually, the cat also holds its target between its front paws. Its ears are pointed upwards or sideways. This may occur in the context of killing prey, foraging or combat. See Table 6.12 Bite (BIT)(E).
	*7. Nibble (NIB)(E)* The cat chews gently, with little pressure, on an object or prey without destroying or hurting it. This may occur when preparing to eat or during play.
	*8. Lick (LIC)(E)* The cat runs its tongue over an object, a prey animal, another individual or parts of its own body. In doing so, it salivates on the surface. This may occur in the context of feeding, or during comfort behaviour such as (social) grooming or kitten care. The papillae of the tongue can "grab" dirt particles when licking fur.
	*9. Retrieve (RET)(S)* The cat transports the captured prey in its mouth and carries it from one place to another. This may occur in the context of hunting prey or transporting kittens.

Table 4. *Cont.*

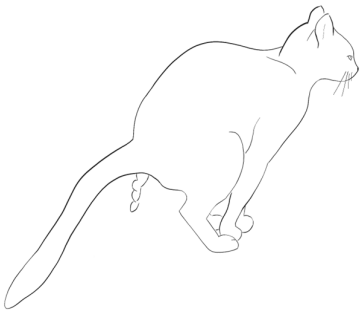
	*10. Eat (EAT)(S)* The cat ingests food through the mouth. It chews pieces of food, salivates on them and swallows them in small portions to digest them and gain energy. The cat normally squats in front of the food. The jaw moves up and down while chewing and the mouth may open and close. Swallowing is recognizable by the food bolus that travels down the throat.
	*11. Drink (DRI)(S)* The cat ingests liquid through the mouth in sips. The cat usually squats in front of the water or other liquid. It quickly and repeatedly dips its angled tongue into the water. When it pulls its tongue back, it uses the surface tension to create a column of water. The cat then "bites" this water column. Its mouth may open and close in the process. Swallowing can be recognized by the typical movement along the throat.
	*12. Defecate (DEF)(E)* The cat selects a spot by sniffing the soil surface. It then digs a shallow pit or hole in the sand or similar substrate. It squats over the hole with its hindquarters towards the opening and defecates into the hole. Afterwards, the cat usually covers the hole with the excavated soil and sniffs repeatedly during the process to check whether it is adequately covered.
	*13. Urinate (URI)(E)* The cat selects a spot by sniffing the soil surface. It then digs a shallow pit or hole in the sand or similar substrate. It squats over the hole with its hindquarters facing the opening and urinates into the hole. The cat may then cover the surface, scratch it and sniff repeatedly during the process.
	*14. Vomit (VOM)(E)* The cat experiences rhythmic gagging movements of the abdomen and throat. Its head is held down towards the floor, its ears are laid forward and its whiskers hang limply to the side. The bolus of food is choked upwards. Afterwards, the cat may smell it and move away. The cat may cover the vomit with a substrate.

Table 5. Rest and sleep.

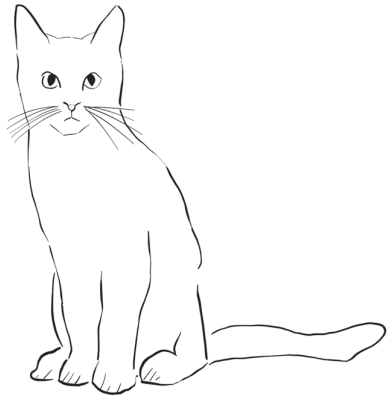
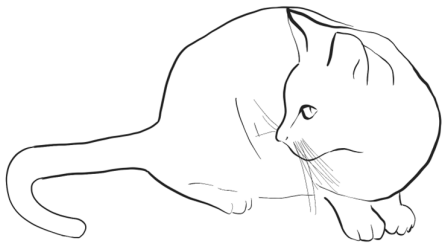
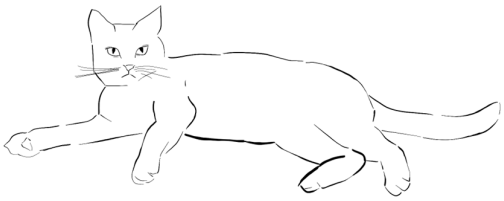
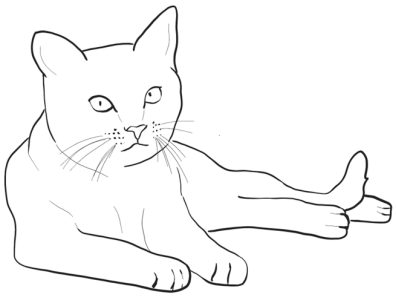
	*1. Sit (SIT)(S)* The cat sits with the hind part of its body completely on the ground. Its front paws touch the ground, and its front legs are fully stretched upward. See Table 2.1. Sit (SIT)(S).
	*2. Squat (SQU)(S)* The cat touches the ground with all four legs. Its belly may touch the ground. Its front paws are placed directly in front of its body. Its head is upright, its neck may be bent and its ears are pointed forwards.
	*3. Roll (ROL)(S)* The cat's back touches the ground, and the front or rear part of its body may be turned or tilted to one side. Its head also rests on the ground. Its belly is exposed.
	*4. Lay on one side (LOS)(S)* The cat touches the ground with one side of its body. Its paws are usually stretched away from its body, and its head is either turned to the side or upright.
	*5. Half lay on the side (HLS)(S)* The underside of the cat's body touches the ground. The cat's front paws are extended forward, sphinx-like. Its body axis is turned to one side from the middle of the trunk. Its head is upright.

Table 5. *Cont.*

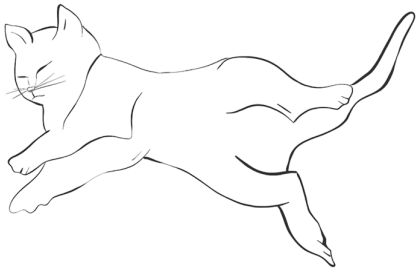
	*6. Lay on the belly (LBE)(S)* The cat touches the ground with the lower part of its body. Its trunk is straight, and its body axis is not shifted to one side. The paws are extended or folded. Its head is upright.
	*7. Lay on the back (LBA)(S)* The cat's back is touching the ground, its belly is upward and its legs may be bent or extended. Its head is usually flat on the ground. Its body axis may be slightly turned to one side.
	*8. Lay curled up (LCU)(S)* The cat touches the ground with one side. The cat's body is turned in on its axis, and its head rests against the side of its body.
	*9. Sleep (SLE)(S)* The cat rests in a squatting position or while lying down. Its head rests on its front paws or the ground. Its eyes are closed. Its body moves up and down in rhythm with its breath.

Table 6. Protection and defence (incl. territorial advertising).

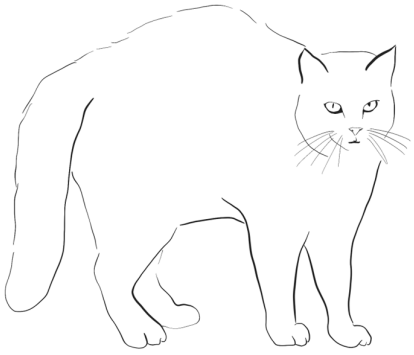
	*1. Cat body freeze (CBF)(E)* The cat stands rigidly. Its head is upright, its neck may be retracted and its muscles are tense. The fur on its neck, back and tail is erect (piloerection). Its posture is similar to the hunchback, but its back is not fully arched.

Table 6. *Cont.*

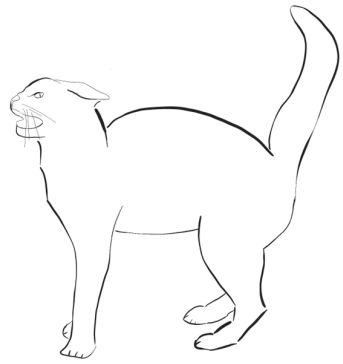
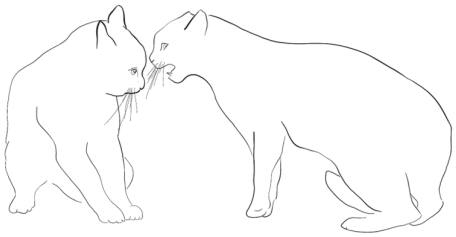
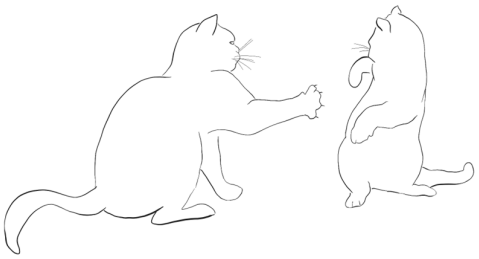
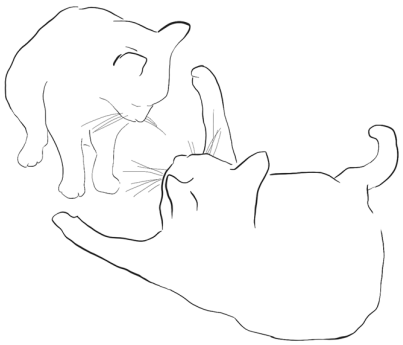
	*2. Curve of back (COB)(E)* The cat arches its back. Its tail is pointed upward, its neck is bent and its head is upright. Its ears may be curved to the side or laid flat against its head. The fur on its neck, body and tail may be erect (piloerection). In this situation, the cat may hiss, produce other vocalizations or open its mouth and bare its teeth.
	*3. Retreat (RTT)(S)* The cat stands in front of another cat or other animal and retreats from the animal while constantly observing it. Snarling or growling may occur. See Table 8.13. Retreat (RTT)(S).
	*4. Strike/cuff (STC)(E)* The cat lifts one or both front paws off the ground and strikes another animal or a human with its paw(s). Its claws are extended.
	*5. Strike without claws (SWC)(E)* The cat lifts one or both front paws off the ground and strikes at another animal or a human with its paw(s). Its claws are retracted.
	*6. Rear (RAC)(E)* The cat sits, squats, stands or lies with its body centre shifted backward. It lifts one or both front paws off the ground in order to strike another animal or a human.

Table 6. *Cont.*

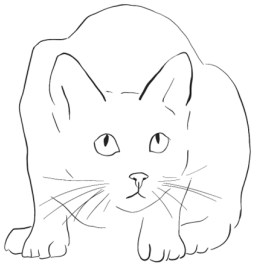
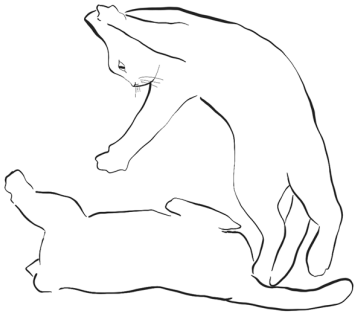
	*7. Stalk/pounce (STA)(S) (STA)(S)* The cat's body is strongly pressed towards the ground. The cat is crouching and moves forward through, e.g., tall grass, a bush or an open field. It simultaneously watches, e.g., potential prey animals. The cat actively and quietly sneaks up on the target by attacking or jumping on it. This may occur in a hunting context or for protection and defence against enemies. See Table 4.2 Stalk/pounce (STA)(S).
	*8. Crouch (CRO)(S)* The cat is crouching. Its body is pressed to the ground and all four legs touch the ground. Its tail may twitch. Its head is also close to the ground, and its neck is outstretched. Its eyes are fixated on an object or another animal, with the pupils mostly wide open. This posture usually occurs in the context of ambushing prey. See Table 4.3 Crouch (CRO)(S).
	*9. Tipple (TIP)(E)* The cat squats and watches, e.g., prey animals. After the cat actively and quietly sneaks up on the target, the cat quickly tipples with its front and hind paws while crouching low to the ground. This is usually immediately followed by attacking or jumping on the prey. This may occur in the context of hunting or for protection and defence against enemies. See Table 4.4 Tipple (TIP)(E).
	*10. Attack jump (ATJ)(E)* The cat approaches another cat, prey or another animal by running or stalking and then moving into the attack jump. The cat may hunch its back while doing this, and the claws on its front and hind legs may be extended. The cat may hiss and make other vocalisations.
	*11. Fight (FIG)(E)* The cat fights with another cat or animal. After an attack jump, the cat strikes with its front paws, claws extended towards the opponent. The fight is a complex interaction of wrestling, biting, scratching, hitting and vocalizations. The goal of both opponents is to acquire or defend a resource (territory, mating partner, food, etc.).

Table 6. *Cont.*

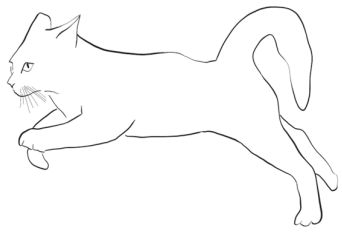
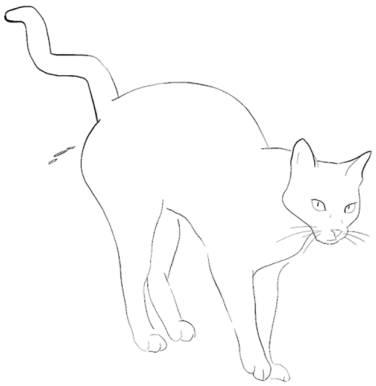
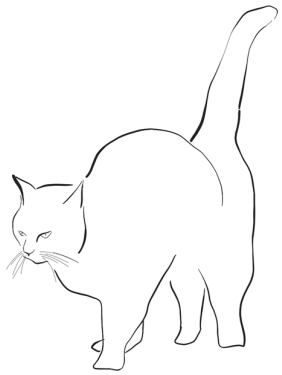
	*12. Bite (BIT)(E)* The cat sinks its teeth into a prey animal, an object, another animal or a human. Usually, the cat also holds or grabs its target between its front paws. Its ears are pointed upwards or sideways. This may occur in the context of killing prey, foraging or combat. See Table 4.6 Bite (BIT)(E).
	*13. Flee (FLE)(E)* The cat moves away from a situation preceded by a new stimulus, a threat or a fight. It runs away from the scene. Its ears may be bent backwards. See Table 8.14 Flee (FLE)(E).
	*14. Urine marking/spray (UMK)(E)* The cat stands with the hind part of its body directed towards an object. Its tail is raised and may tremble. The cat releases a stream of urine backwards against the object. This action occurs in the context of marking. See Table 10.3 Urine marking (UMK)(E).
	*15. Pseudo urine marking (PMK)(E)* The cat stands with the back of its body towards an object. Its tail is raised and may tremble, but no urine stream is emitted. This action occurs in the context of marking.
	*16. Stroke marking (STO)(E)* The cat stands or squats, rubbing the side of its body along the floor or an object. It secretes a scent from the cheek gland.

Table 6. *Cont.*

	*17. Scratch marking (SCM)(E)* The cat sinks the claws of its front paws into an object, e.g., a tree or a piece of furniture. It then stretches its arms and pulls them repeatedly backward along the object and wears down its claws while emitting a scent from the paw gland.

Table 7. Comfort behaviour.

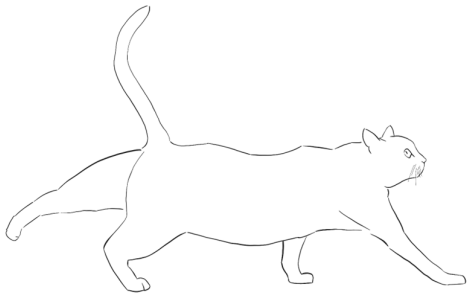
	*1. Scratch the body with hind legs (SBL)(E)* The cat sits and uses one of its hind paws to scratch its side or another part of its body, e.g., its ears, in rapid succession.
	*2. Stretch (STR)(E)* The cat stands or walks while extending all legs away from the centre of its body and lengthening its torso.
	*3. Sharpen claws (SHC)(E)* The cat sits or crouches in front of an object and sinks its claws into the object. It then sharpens its claws using alternating pulling movements of its front paws along the object. Sharpening claws often comes together with scratch marking. Scratch marking can be short and concentrated, while sharpening claws usually occurs more intensively and is long-lasting in one place, with the aim not only to make a mark but to sharpen the claws through abrasion with the substrate.

Table 7. *Cont.*

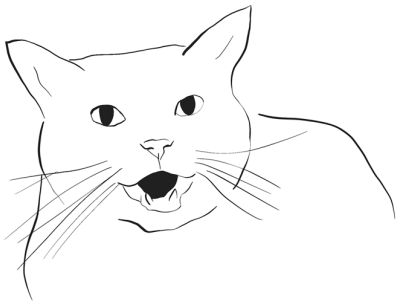
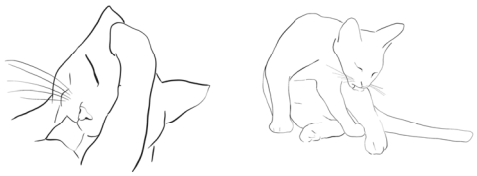
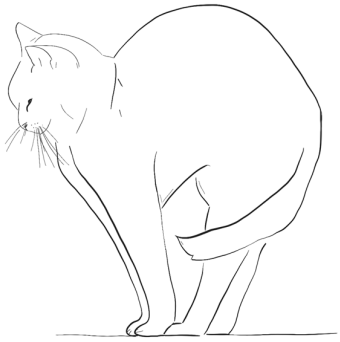
	*4. Yawn (YAH)(E)* The cat sits, squats or stands, opening its mouth wide and exhaling air. Yawning is usually accompanied by audible inhalation and exhalation, as well as additional vocalizations, and usually occurs in the context of rest and recovery.
	*5. Flehmen (FLE)(E)* The cat opens and closes its mouth in a fast rhythmic movement to carry scents from the air to the roof of its mouth. It may also extend its tongue in the process. This behaviour, also known as flehming, usually occurs in the context of mating behaviour [49,50]. See Table 3.5 Smell/sniff (SME)(E) and Table 10.1 Flehmen (FLE)(E).
	*6. Groom (GRO)(S)* The cat sits, squats or lies down while licking its fur with its tongue. To reach its head, the cat licks its front paws and strokes them across its head and ears. By otherwise directly licking each body part, the cat cleans its entire body. The cat may bite and suck on its fur to loosen a small knot or remove a stuck particle.
	*7. Knead (KND)(E)* The cat alternately steps on a soft object (e.g., a pillow or blanket) or on body parts of another animal or a human with its front paws. In doing so, the cat alternates back and forth between retracting and extending the claws on its front paws, which may slightly lift the substrate. Kneading is an example of cat juvenile behaviour retained into adulthood and directed towards humans by domestic cats [11].
	*8. Cat hunchback (CHB)(E)* The cat sits or squats. It then stands up, curves its back upwards and stretches its legs. Its tail is usually also stretched out or curved around its body, and the fur may be erect on both its tail and its back. This may occur, e.g., after a period of rest. See Table 1.12 Cat hunchback (CAH)(E).

Table 8. Social behaviour.

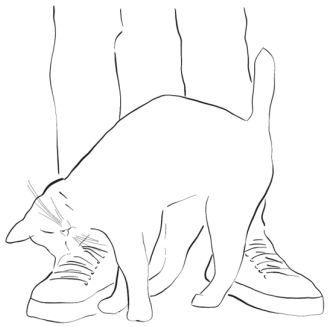
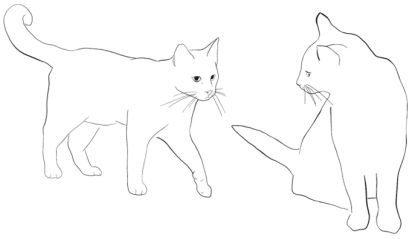
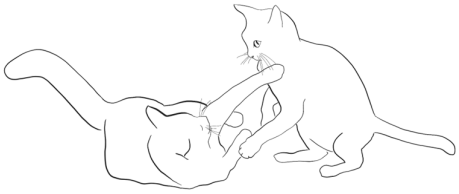
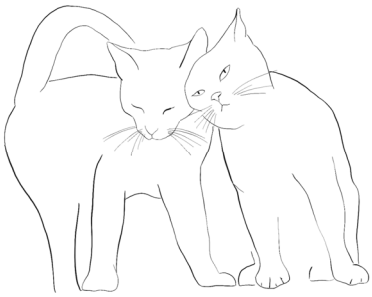
	*1. Approach human (APH)(E)* The cat approaches a human. Its head is upright, there may be vocalizations such as meowing or purring and the cat initiates eye and/or body contact. Its tail may be curved around its body, its ears are pointed forward and its eyes may open and close slowly.
	*2. Stroke against human (STH)(E)* The cat rubs its head or the sides of its body against the legs or other body parts of a human.
	*3. Cheek marking (CMK)(E)* The cat brushes its cheek or whole head over an object or the body parts of an animal or human and secretes a scent from the cheek gland.
	*4. Approach another cat (APC)(E)* The cat approaches another cat (or other animal). Its head is upright, vocalizations such as meowing or purring may occur and the cat initiates eye and/or body contact.
	*5. Pat paw (PAW)(E)* The cat pats another individual with its front paw in a dabbing motion. The claws of this paw are retracted. This may occur during social play or other social interactions.
	*6. Stroke another cat (STK)(E)* The cat rubs its cheek or forehead area or its whole body along the flanks against another cat (or animal). The two cats' tails may be intertwined (see Macdonald et al., 1987).

Table 8. *Cont.*

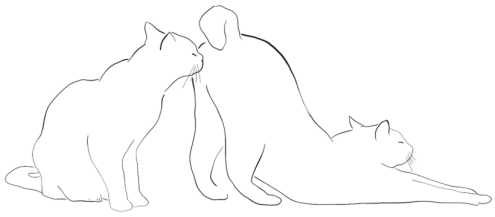
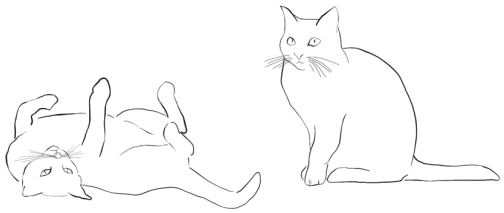
	*7. Allogroom (SGR)(E)* The cat sits, squats or lies in close contact with another cat (or other animal) and licks the other cat's fur with its tongue.
	*8. Smell another cat (SAC)(E)* The cat smells and sniffs the body parts of the other cat (or another animal).
	*9. Walk with another cat (WWC)(E)* The cat walks together with another cat side by side. The flanks of the cats may be close together and their tails may be entwined.
	*10. Contact with another cat (CWO)(S)* The cat is sitting, crouching or lying in physical proximity to or in contact with another individual.
	*11. Social roll (RIC)(E)* The cat rolls from side to side while lying on the floor in the presence of another cat. This may occur in a friendly and relaxed context, in a submissive, playful context or towards humans.
	*12. Avoid interaction (AVI)(E)* The cat stands, crouches or sits in front of another cat (or animal) after an approach and reacts by avoiding eye contact, turning its head away.

Table 8. *Cont.*

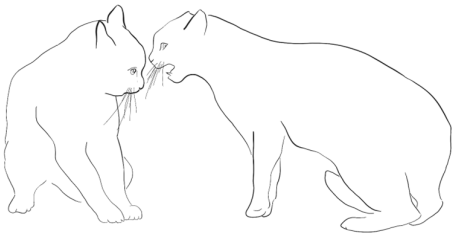
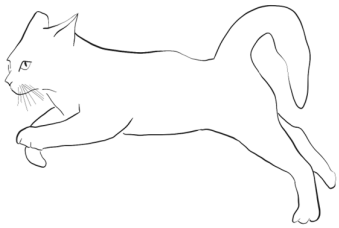
	*13. Retreat (RTT)(S)* The cat stands in front of another cat or other animal and retreats from the animal while constantly observing it. Snarling or growling may occur. See Table 6.3 Retreat (RTT)(S).
	*14. Flee (FLE)(E)* The cat moves away from a situation preceded by a new stimulus, a threat or a fight. It runs away from the scene. Its ears may be bent backwards. See Table 6.12 Bite (BIT)(E).

Table 9. Play and learning behaviour.

	*1. Object play (PWO)(E)* The cat focuses its attention on an object, examining it with its eyes and paws. Play is a complex process of moving the object, feeling it, nibbling on it, swatting it away, running after it, wrestling with it, etc. The goal is playful learning of movement sequences [51,52].
	*2. Play by oneself/locomotor play (PBO)(E)* The cat chases its tail or runs from one side to another. This occurs in the context of locomotor play movement in any or every direction for its own sake [51,52].
	*3. Social play (SOP)(E)* The cat plays with another cat, an animal or a human. This occurs in the context of social interactions and may include running, pawing, jumping and playful fighting [53,54].

Table 10. Reproductive behaviour.

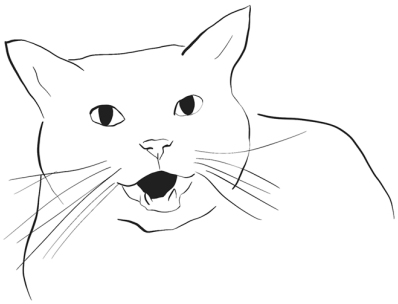
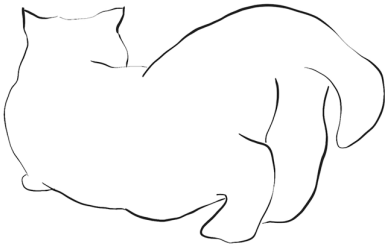
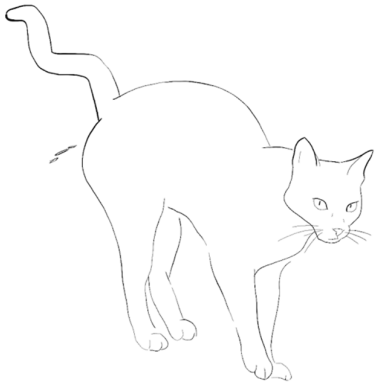
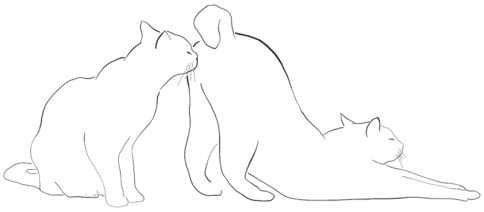
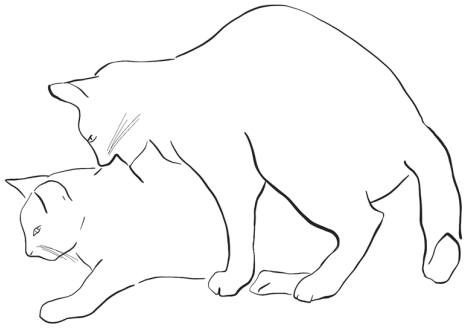
	*1. Flehmen (FLE)(E)* The cat opens and closes its mouth in a fast rhythmic movement to carry scents from the air to the roof of its mouth. It may also extend its tongue in the process. This behaviour, also known as flehming, usually occurs in the context of mating behaviour [49,50]. See Table 3.5 Flehmen (FLE)(E) and Table 7.5 Flehmen (FLE)(E).
	*2. Cat in heat (CIH)(S)* The female in oestrus often rolls on the ground from side to side while twitching her tail. She presses the underside of her body close to the ground and raises her abdomen to present her genital opening, assuming the lordosis position. In this way, the female tries to attract males.
	*3. Urine marking (UMK)(E)* The cat stands with the hind part of its body directed towards an object. Its tail is raised and may tremble. The cat releases a stream of urine backwards against the object. This action occurs in the context of marking [55]. See Table 6.14. Urine marking/spray (UMK)(E).
	*4. Courtship behaviour (CSB)(E)* The male approaches the female and makes one or more attempts to establish body contact. This may include grooming/licking the female's neck or head. The female either defends herself by, e.g., hissing or striking with her paws or complies and enters the lordosis position.
	*5. Mount (MOU)(E)* The male mounts the female, who presses the underside of her body close to the ground and raises her hind body (lordosis). The male holds the female in place between his front legs. He may additionally hold her on the ground by biting the nape of her neck (neck bite).

Table 10. *Cont.*

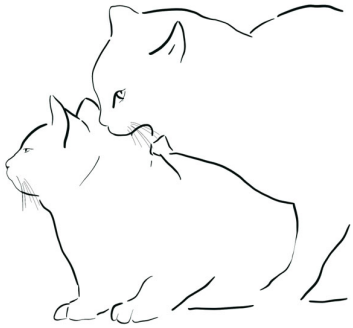
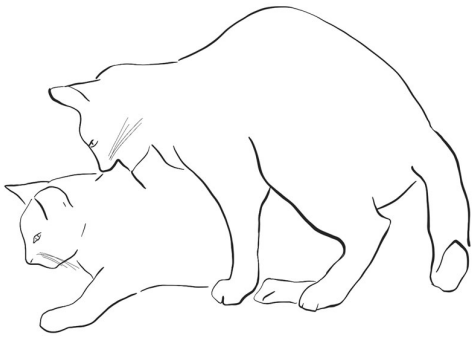
	*6. Neck bite (NEB)(E)* The male mounts the female. He holds her in place using his body and a neck bite. The teeth often do not penetrate the skin, as the male usually does not use his jaw muscles' full power.
	*7. Copulation/penetration (COP)(E)* The male lowers his hindquarters towards the female until the penis is inserted into the vagina. Penetration is indicated by thrusting movements of the male's pelvis and ends with ejaculation. Copulation overall is brief and may last from a few seconds to minutes. The male holds the female in place during the act by biting her neck. The female may hiss or make other vocalizations. After ejaculation, the male leaves the female.
	*8. Groom genitals (GRG)(E)* The male or female cat breaks away after mating, lies down on one side and inspects or cleans its genitals with its tongue.

Table 11. Mother–kitten interactions.

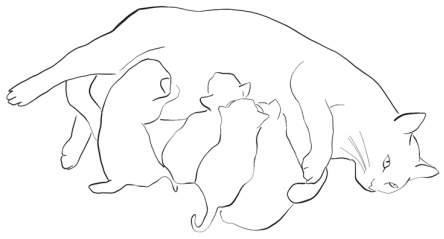
	*1. Mother gives birth (MGB)(S)* The female lies in a (usually) safe environment and licks and examines her genital opening several times. During labour, the abdomen may visibly move due to movements of the kittens or contractions of the womb. The mother may pant or purr during delivery. Once a kitten is born, the mother licks it free of embryonic membranes and amniotic fluid until the kitten is dry and eats the umbilical cord.
	*2. Mother nurse (MNU)(S)* The female lies on one side so that the kittens can reach the teats. The female keeps still and relaxed while nursing her kittens.

Table 11. *Cont.*

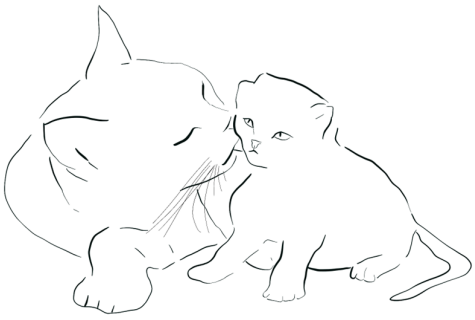
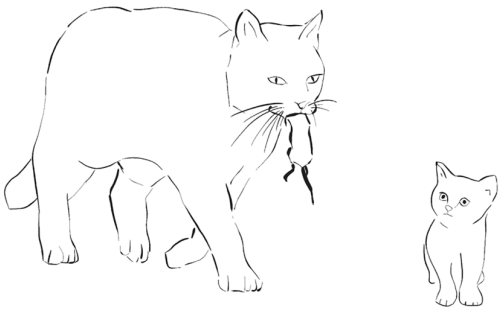
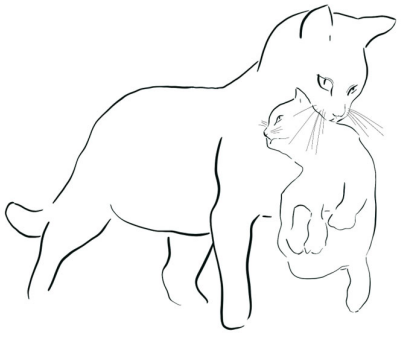
	*3. Mother cleans kitten (MCK)(S)* The female stands, lies or sits in front of a kitten. She may hold the kitten in place with one or both paws. She cleans it from head to toe with her tongue. At an early age, its excretions are also cleaned away by the mother. She also licks its anogenital region specifically to stimulate excretion.
	*4. Mother fetches kitten (FEK)(E)* The mother carries the kitten back to the nest or transports the kitten to a new location by grabbing it by the scruff of its neck, picking it up and then carrying it in her mouth. She then places down the kitten at the destination.
	*5. Mother brings food (BFO)(E)* The mother carries the prey to her kittens and places it in front of them so that they can sniff at the prey and eat it. If the kittens are older, the mother can also carry live prey into the nest to teach them how to kill it.
	*6. Kitten calls mother (KCM)(E)* The kitten uses a typical vocalization to call its mother to turn towards it, protect it or feed it. When the kitten's eyes are still closed, vocalization is often used to contact the mother.
	*7. Carry a rigid kitten (KCR)(S)* The kitten, which is carried by the mother, is triggered by her neck bite to stiffen its body. When kitten is set down, it moves again.

Table 11. *Cont.*

	*8. Kitten drinks and kneads (KDK)(S)* The kitten orients itself towards the mother's belly and searches for the teats. After enclosing a teat in its mouth, the kitten drinks, moving its lower jaw in a swallowing motion. While drinking, it kneads with the paws next to the teat to stimulate the flow of milk.

Table 12. Vocalisations.

1. Chatter (CHA)(E)
The cat rhythmically clashes its jaws, creating a low-amplitude, smacking sound mostly in the context of flehming or hunting [35].
2. Chirp (CHI)(E)
The cat produces a short, high-pitched call that is described as similar to a bird chirping [35].
3. Copulatory cry (CPC)(E)
The female cat cries during successful intromission with a low, barely audible growl [56].
4. Growl (GRO)(E)
The cat produces a low-pitched, throaty, rumbling noise produced while the mouth is closed, mostly in the context of fighting or defence [35].
5. Hiss (HIS)(E)
The cat produces a long, soft hissing sound made by rapidly expelling air from the cat's mouth, usually when exhaling [35].
6. Yawn (YAH)(E)
The cat yawns, opens its mouth, inhales deeply and produces a deep sound reminiscent of meowing. It may be followed by short clicks as it shuts its mouth [35]. See Table 7.4. Yawn (YAH)(E).
7. Yowl (YOW)(E)
The cat produces a long drawn-out vocalisation of variable pitch, intensity and duration [35].
8. Meow (MEO)(E)
The cat produces a guttural meow sound, which may be of varying length and depth. Originating in the context of mother and kitten interactions, the meow is used to communicate with humans [56].
9. Purr (PUR)(S)
The cat produces a deep, rhythmic vibrating sound emanating from its throat and chest. It is heard both on exhalation and inhalation [57].
10. Sneeze (SNE)(E)
The cat makes a short hissing sound through its nose and open mouth, moving its head quickly from top to bottom. This behaviour serves as a defence reflex for small particles in the nose [58].
11. Spit (SPI)(E)
The cat produces a sudden, explosive exhalation, often accompanied by violent movement [35].
12. Trill (TRI)(E)
The cat produces an abbreviated trill, which is usually heard in the context of mother and kitten interactions or in interactions with humans [35].

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/pets1030021/s1, we offer one link containing the video material of cats performing different kinds of vocalisations https://zenodo.org/record/8404046 (accessed on the 10 October 2024), as well as all Supplementary Material in one zip file: https://zenodo.org/records/13942343 (accessed on the 10 October 2024).

Author Contributions: Conceptualisation and resources: I.K.; methodology, research, writing and editing: I.K., F.B., M.-C.R., S.H. and N.W.-Z.; illustration: M.-C.R.; video analysing: the research group; project management: I.K. and U.G. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The procedures for the video recordings of domestic cats in the period 2017–2023 were carried out by the research group. As this study does not contain any ethically relevant data according to the ethics committee of the University of Jena, the need for ethical approval was waived.

Informed Consent Statement: According to German animal welfare regulations, no permission is needed to observe undisturbed animals (except for threatened wildlife) in their everyday life. The owners of the cats gave informed consent for this behavioural research to allow us to observe their pets on private grounds.

Data Availability Statement: Original data are available from the corresponding author upon reasonable request.

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Conflicts of Interest: The authors declare no conflicts of interest.

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