## Title
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# A Case Study of Spontaneous Category Formation and Behavioral Expression in a Language-Trained Steller Sea Lion (*Eumetopias jubatus*)

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The purpose of this study was to examine the responses of a Steller sea lion to two consecutive commands. We conducted this study on the subject, Hama, as a continuation of Sasaki et al. (2022), which examined whether a Steller sea lion can discriminate human vocal commands. In Sasaki et al. (2022), commands were presented individually to examine the accuracy rate for each command. In the present study, we observed how Hama responded to the rapid presentation of two consecutive commands. The commands were presented in 20 different orders with 20 command combination patterns using five different commands. The results showed that Hama responded to 12 command combination patterns by performing behaviors corresponding to two consecutive commands. Hama performed the two behaviors in sequence for eight of the 12 command combination patterns. The responses to the other four command combination patterns were combined single behaviors that joined the behaviors indicated by the two consecutive commands and that were already connected to different single commands. Although the combined single behaviors were not simple combinations of behaviors induced by the two consecutive commands, the combined single behaviors included the common body parts (e.g., foreflippers) or common action types (e.g., rotation) of behaviors induced by each command in the two consecutive commands. These results not only indicate that Hama could understand multiple linguistic information, but also suggest the possibility that Hama spontaneously formed categories based on the learned commands.

「言語訓練したトドに見られた自発的なカテゴリの形成と動作の表現」

本研究の目的は、連続する 2 つの音声コマンドに対するトドの反応を調べることである。本研究は、トドがヒトの音声コマンドを識別できるかどうかを検討した佐々木ら（2022）の続編として、同じ供試個体であるトドのハマ 1 頭を対象に実施した。佐々木ら(2022)では、コマンドを 1 つずつ個別にハマに提示し、それぞれのコマンドの正解率を調べた。本研究では、2 つのコマンドを素早く連続で提示したときに、ハマがどのように反応するかを観察した。5 種類のコマンドを用い、20 通りの順序と組み合わせで提示した。その結果、12 通りの組み合わせに対して、ハマは提示された 2 つのコマンドそれぞれに対応する行動を順番に行った。残りの 4 通りの組み合わせパターンに対する反応は、提示された 2 つのコマンドが示す行動を組み合わせた複合単一行動であり、それらはすでにハマが学習している別のコマンドと条件づけられた行動であった。これらの複合単一行動は、提示された 2 つのコマンドが示す行動の単純な組み合わせではなかったが、2 つのコマンドが示す動作と共通する身体部位（例：前肢）や共通する動作（例：回転）が含まれていた。これらの結果は、ハマが複数の言語情報を理解できることを示すだけでなく、学習したコマンドに基づいて自発的にカテゴリーを形成している可能性を示唆している。

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**Un Estudio de Caso de Formación Espontánea de Categorías y Expresión Conductual en un León Marino de Steller (*Eumetopias jubatu)* Entrenado en Idiomas**

El propósito de este estudio fue evaluar las respuestas de leones marinos de Steller a dos órdenes consecutivas. Realizamos este estudio sobre un mismo sujeto, Hama, como continuación de Sasaki et al. (2022), que examinaron si el león marino de Steller puede discriminar las órdenes vocales humanas. En Sasaki et al. (2022), los comandos se presentaron individualmente para examinar la tasa de precisión de cada comando. En el presente estudio, observamos cómo Hama respondió a la presentación rápida de dos comandos consecutivos. Los comandos se presentaron en 20 órdenes y combinaciones diferentes, de manera que resultan 20 patrones de combinación de comandos usando cinco comandos diferentes. Los resultados mostraron que Hama respondió a 12 patrones de combinación de comandos realizando comportamientos correspondientes a dos comandos consecutivos. Hama realizó los dos comportamientos en secuencia en 8 de los 12 patrones de combinación de comandos. Las respuestas a los otros cuatro patrones de combinación de comandos fueron comportamientos únicos que combinaban los comportamientos indicados por los dos comandos consecutivos y que ya estaban conectados a diferentes comandos únicos. Aunque las conductas individuales combinadas no eran simples combinaciones de conductas inducidas por dos órdenes consecutivas, las conductas individuales combinadas incluían partes del cuerpo comunes (e. g., aletas delanteras) o tipos de acciones comunes (e. g., rotación) de conductas inducidas por cada orden en la secuencia en los dos comandos consecutivos. Estos resultados no sólo indican que Hama podría comprender información lingüística múltiple, sino que también sugieren la posibilidad de que Hama formara categorías espontáneamente basadas en las órdenes aprendidas.

*Keywords*: acoustic signal, categorization, pinniped, training, word learning

The ability to understand language in nonhuman animals has been studied in several species. Cases of sign language use have been reported in chimpanzees (*Pan troglodytes*: Gardner & Gardner, 1969), bottlenose dolphins (*Tursiops truncatus*: Herman et al., 1984), and the California sea lion (*Zalophus californianus*: Schusterman & Krieger, 1984). In addition, cases of human voice use have been reported in the walrus (*Odobenus rosmarus*: Endo et al., 2020), the parrot (*Psittacus erithacus*: Pepperberg, 1981), the dog (*Canis lupus familiaris*: Pilley & Reid., 2011), and others. In another case, a chimpanzee was taught vocabulary using a small piece of plastic (Premack, 1970). These previous studies mentioned above indicate that animals can learn associations between linguistic information and referents (events and objects).

However, there have been some reported cases in which more developed linguistic understanding has been studied. Washoe, a female chimpanzee, learned hand signs and spontaneously combined them to represent novel objects (Gardner & Gardner, 1969). Herman (2010) reported that language-trained bottlenose dolphins can understand sentences of about five words, using human gestures or computer-generated acoustic signals. Pilley and Reid (2011) reported that border collies can understand two-word sentences using human speech. Although these findings were based on single or very few individuals, they indicate that animals may be able to use language creatively or understand syntactic structures consisting of multiple words.

In the sea lion species, language learning has been studied in California sea lions (Schusterman & Gisiner, 1988; Schusterman & Krieger, 1984). For instance, Schusterman and Gisiner (1988) showed that California sea lions can understand signals about the relationship between two specified objects using sign language. Schusterman and Krieger (1984) showed that California sea lions can understand syntactic structures using three gestures indicating modifiers, nouns, and verbs. All of these studies used hand signals as linguistic information. Although sea lions communicate with each other using their vocalizations (Peterson & Bartholomew, 1969), no study has reported the results of language learning in a sea lion species using acoustic cues, with the exception of a previous study of a Steller sea lion (*Eumetopias jubatus*: Sasaki et al., 2022).

Individual Steller sea lions, like other sea lion species, use vocalizations to communicate with others (Campbell et al., 2002; Loughlin, 2009). The Steller sea lion of the North Pacific Ocean is the largest of the otariid pinnipeds. Sexual dimorphism is pronounced, with average body weights of 556 kg for males and 263 kg for females (Loughlin, 2009). The Steller sea lion forms large social groups, and they make vocalizations in a variety of situations, such as in threatening others, courting, and mothers communicating with their pups (Loughlin, 2009). Individual females have distinctive voices, allowing pups to recognize their mother's voice (Campbell et al., 2002). Mothers and pups communicate by calling to each other (Campbell et al., 2002).

At Kinosaki Marine World, we have been training Steller sea lions with the use of human vocal commands since 2014. The vocal commands used are word-level commands given by the human voice (Sasaki et al., 2022). In the learning phase, we used food as a reinforcer to associate behavior with linguistic information (i.e., vocabulary). In the test phase in 2018, we examined the behavioral responses to linguistic information by measuring the accuracy rate. The results from discrimination experiments using directly delivered and recorded voices showed that the female Steller sea lion, Hama, could correctly associate 10 commands with specific behaviors, regardless of the trainer or the trainer's gender (Sasaki et al., 2022). This previous study is a case study of audio discrimination ability, while this previous study also reported the first findings of language learning using acoustic cues, which has not been reported in the sea lion species.

The purpose of this study was to examine the responses to multiple linguistic information in an individual Steller sea lion, Hama. Hama's responses to multiple linguistic information were not examined in the 2018 experiment conducted by Sasaki et al. (2022). In the previous study, Hama was able to discriminate vocal commands presented individually with a high accuracy rate (Sasaki et al., 2022). We therefore predicted that Hama would sequentially perform the correct responses indicated by the two consecutive commands. As a continuation of the experiment conducted in 2018 that only examined Hama's responses to "single" linguistic information using human voice (Sasaki et al., 2022), this study reports the first case study in the sea lion species to examine individual responses to "multiple" linguistic information using human voice.

## Method

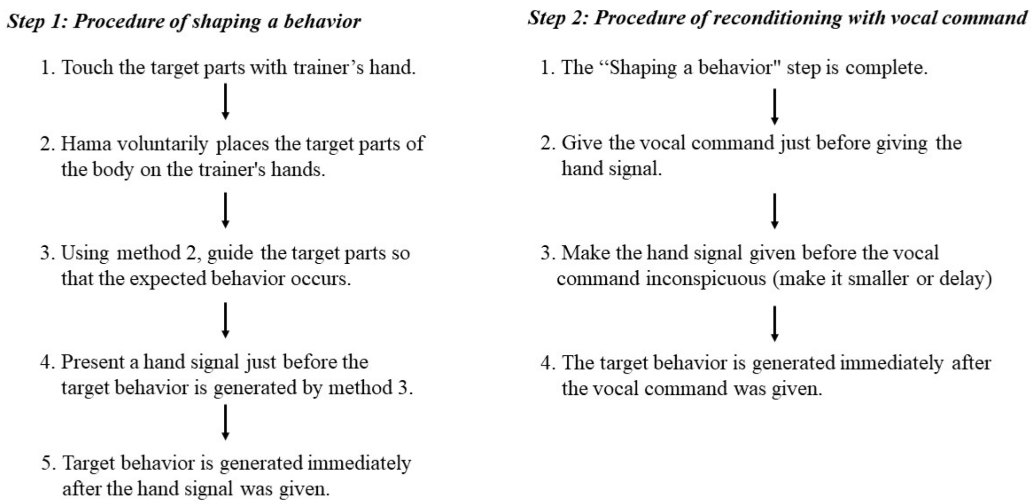
### Subject

The subject was one female Steller sea lion, Hama (Sasaki et al., 2022). In the previous study, no other Steller sea lions were reported to have sufficiently learned vocal commands except for Hama, and no other individuals were available for comparison at a similar level. It may be pointed out that experiments with small sample sizes may lead to unreliable results, but most previous studies on language learning in California sea lions, bottlenose dolphins, and chimpanzees have been conducted with small sample sizes (one or two animals) (e.g., Gardner & Gardner, 1969; Herman et al., 1984; Schusterman & Krieger, 1984).

Hama was brought to Kinosaki Marine World in Hyogo, Japan on June 14, 2011. She has undergone training to discriminate commands since April 1, 2014 according to the training method described by Sasaki et al. (2022). Figure 1 shows the details of the procedure for learning the commands. After the experiment conducted by Sasaki et al. (2022) in 2018, Hama continued training to learn new commands. Table 1 shows the 50 commands Hama has learned from 2014 to the present and when each command was learned.

**Figure 1**

*Command Learning Procedure*




*Note.* First, the conditioning was conducted in the order indicated by the arrows in Step 1. After Step 1 was completed, Step 2 was conducted.

**Table 1**

*Associations Between Vocal Commands and Referential Behaviors*

| Vocal commands | Behaviors |
|---|---|
| *Learning period: From April 1, 2014 to March 15, 2015* | |
| bye-bye | Swinging her left foreflipper. |
| chin-chiro-rin | Swinging both hindflippers. |
| goron | Lying on her back. |
| Hama | Barking once. |
| huse | Lying on her face. |
| keirei | Attaching her back side of right foreflipper to her nose. |
| mate | Not moving on the spot. |
| ohuro | Entering the pool. |
| oide | Coming in front of the trainer. |
| omawari | Rotating on an axis perpendicular to the ground. |
| oshiri | Turning around and getting down. |
| yoshi | Terminating the behavior being performed.<br>*It also serves as a bridging stimulus. |
| *Learning period: From April 1, 2015 to November 30, 2016* | |
| arn | Opening her mouth. |
| batten | Lying on her back and crossing her foreflippers. |
| be- | Sticking out her tongue. |
| hu- | Breathing out through her nose. |
| iya-iya | Shaking her head from side to side. |
| migite | Taking her right foreflipper out of the cage. |
| nage-kiss | Attaching her palm side of left foreflipper to her nose and flapping it. |
| okay | Shaking her head up and down. |
| onaka | Putting the abdomen to the wall. |
| *Learning period: From December 1, 2016 to December 1, 2018* | |
| bata-bata | Shaking both foreflippers in prone position. |
| gedan-itte | Flippering to the lower level of the rock pile in the exhibition pool. |
| hakushyu | Falling on her left side and lying on her back. Then, swinging both forflippers. |
| kurun | Rotating on a horizontal axis with the ground. |
| ni | Lifting up the corners of her mouth. |
| shima-ittte | Moving to the land space on the stage side in the exhibition pool. |
| touritsu | Standing upside down. |
| ushiro | Turning around and standing still. |
| wakka | Putting her hindflippers to her head. |
| *Learning period: From December 2, 2018 to March 1, 2021* | |
| acha- | Lying on her back and attaching her palm side of right foreflipper to her nose. |
| go-go | Flippering to the top of the rock in the exhibition pool. |
| huri-huri | Shaking her bottom to the left and right. |
| kick | Jumping and kicking the hindflippers upward. |
| kiritsu | Standing up to the cage. |
| kune-kune | Shaking her body while lying on her back. |
| orite | Returning to the original position from a standing position. |
| pan-pan | Waving her hind flippers while standing upside down. |
| pin-kyu | Extending the beard upwards and contracting it. |
| toku | Moving to the land space farther from the stage in the exhibition pool. |
| *Learning period: From March 2, 2021 to April 1, 2022* | |
| "pool"noheya | Moving to the animal house next to the right. |
| "tonari"noheya | Moving to the animal house next to the left. |
| dashite | Putting out her left hind leg from between the grating. |
| gara-gara | Catching the water pouring in the mouth.<br>*Water pouring is always out in the animal house. |
| goshi-goshi | Falling on her left side and lying on her back. Then, swinging both foreflippers. |
| ha-i | Raising the left foreflipper and holding it still. |
| hoy | Turning over and attaching her palm side of left foreflipper to her nose, and flapping it. |
| inainai | Turning over and attaching her palm side of both foreflippers to her nose, and flapping it. |
| massugu | Extending the hind legs and aligning the body with the grating. |
| spin | In a prone position, rotating on an axis perpendicular to the ground. |

**Housing and Maintenance**

Hama was kept in the exhibit pool shown in Figure 2 as her main living place and in the animal house shown in Figure 3 during training time. The details of each facility and the method of maintaining Hama are described in Sasaki et al. (2022).

**Figure 2**

*The Exhibition Pool*


*Note.* Box 1 indicates the lower level of the rock. Box 2 shows the top of the rock. Box 3 indicates the land space on the stage side. Box 4 shows the land space farther from the stage. Box 5 indicates a space between the exhibition pool and the animal house.

**Figure 3**

*The Animal House where the Experiment was Conducted*


*Note.* Arrow 1 indicates the grate door. This door was closed during the experiment. Arrow 2 shows the position of a faucet for seawater injection. Arrow 3 shows a steel door. The steel door was closed during the experiment.

**Vocal Commands**

To facilitate spontaneous responses to novel stimuli (two consecutive commands), we selected only five commands from her learning repertoire to reduce her load. The first four commands were “keirei,” “bye-bye,” “omawari,” and “go-ron,” which had the longest learning history and had correct response rates of over 95% in the previous experiments (Sasaki et al., 2022). The command “touritsu” was also added in this experiment.

**The Experimenter**

The experimenter was a male trainer who had the longest history of training with Hama. Hama was used to responding to commands given individually. Hama was also accustomed to being given single commands by various people. Therefore, multiple trainers participated as experimenters in the previous experiment (Sasaki et al., 2022). On the other hand, this study was the first time that two consecutive commands were given to Hama. Only one familiar trainer participated in this experiment because of the possibility that the timing of giving the commands and the manner in which the commands were given could not be standardized. The familiar trainer was chosen as the experimenter to avoid the risk that Hama would show refusal or not respond at all to the "two consecutive commands" that she was exposed to for the first time.

**Methods to Give Two Consecutive Commands**

All learning sessions were conducted with Hama alone in the animal house. The experimenter gave the two consecutive commands as quickly as possible. Because there was a possibility that Hama might start her reaction in the middle of giving a command. The experimenter gave the second command to Hama within 1 s after the first command and observed Hama’s responses. To minimize the influence of the experimenter’s gaze and movements as much as possible, the experimenter crouched down in front of Hama and fixed his eyes on Hama’s eyes. We did not prespecify the combination of two consecutive commands or the order that we gave them to Hama during the training. The experimenter also tried not to present the same command consecutively.

**The Experiment Period and Number of Trials**

To examine Hama’s spontaneous behavior, we conducted behavioral observations for the first two days of this initiative (from 10:00 a.m. to 10:30 a.m. on January 15 and January 16, 2022). Given that the repetition of sessions could affect Hama’s response patterns, the number of trials for each command combination pattern was limited to five (20 trials in total).

**Methods of Evaluations to Responses**

We excluded some of Hama’s responses from our analyzed data.

1. No reaction
2. Reaction to only one of the commands
3. Behavior that appears to be an obvious mishearing

(For example, in response to the two consecutive commands “keirei + omawari,” Hama performed the behavior indicated by “bye-bye” after the behavior indicated by “keirei.” We judged these responses to be errors due to mishearing).

We excluded these data from the analysis of this study because it could take time for Hama to recognize the situation in which two consecutive commands are given and to understand the experimenter's intention that she must respond to two consecutive commands. However, for those two consecutive commands in which these exclusion behaviors were observed five times in a row, we rated them as “unable to respond to two consecutive commands.” Finally, responses that did not fit the exclusion criteria were used in the analysis.

On the other hand, all responses of Hama to two consecutive commands (e.g., two behaviors in sequence) were reinforced and recorded. The percentage of each behavior was calculated for the behaviors that were targeted for analysis.

# Results

Hama showed two response patterns to the two consecutive commands. The first response pattern was to perform two behaviors in sequence. Hama performed correct responses in the order in which the two consecutive commands were given. The second response pattern was in which Hama responded with a single behavior that combined the two behaviors indicated by each command. In this case, Hama responded to the second command with a slightly different behavior than the correct response.

**Response Patterns where Hama Performed Two Consecutive Behaviors Indicated by Two Consecutive Commands.**

Table 2 shows the type and order of two consecutive commands, and the response of Hama to two consecutive commands. Hama completed the behavior indicated by the first command and moved to the behavior indicated by the next command within 5 s without any additional stimuli (i.e., bridging stimulus or command) from the trainer. Except for the excluded behaviors described in the "Methods" section, the occurrence rate of each behavior was 100%.

However, eight command combination patterns only produced the behaviors that violated the exclusion criteria (see Table 2).

**Table 2**

*Two Consecutive Commands, Behaviors, and Frequencies of Behaviors*

| First commands | Second commands | Behaviors | Frequencies (%) |
|---|---|---|---|
| bye-bye | goron | "bye-bye" behavior → "goron" behavior | 100 |
| bye-bye | keirei | "bye-bye" behavior → "keirei" behavior | 100 |
| bye-bye | omawari | "bye-bye" behavior → "omawari" behavior | 100 |
| bye-bye | touritsu | - | |
| goron | touritsu | - | |
| keirei | bye-bye | "keirei" behavior → "bye-bye" behavior | 100 |
| keirei | goron | "keirei" behavior → "goron" behavior | 100 |
| keirei | omawari | "keirei" behavior → "omawari" behavior | 100 |
| keirei | touritsu | - | |
| omawari | bye-bye | - | |
| omawari | goron | "omawari" behavior → "goron" behavior | 100 |
| omawari | keirei | "omawari" behavior → "keirei" behavior | 100 |
| omawari | touritsu | - | |
| touritsu | goron | - | |
| touritsu | keirei | - | |
| touritsu | omawari | - | |

*Note.* "-" means that Hama did not perform any actions. Each behavior conditioned to each command was shown in Table 1. Frequencies indicate the percentage of each behavior was calculated for the behaviors that were targets for analysis. Videos (Video 2 to Video 9) show two consecutive commands and behaviors (https://osf.io/shf8c/?view_only=194f41a311034281a776292db999dd28).

**Response Patterns where Hama responded with a single behavior combined the two behaviors indicated by each command.**

Table 3 shows the type and order of two consecutive commands and the single behavior response to two consecutive commands. In each case, as shown in Table 3, the specific two consecutive commands induced combined single behaviors that combined the behaviors indicated by the two consecutive commands and that were already connected to different single commands. The specific two consecutive commands were certain to induce the specifically combined single behaviors. In addition, although the combined single behaviors were not simple combinations of behaviors induced by the two consecutive commands, the combined single behaviors included the common body parts (e.g., foreflippers) or common action types (e.g., rotation) of behaviors induced by each command in the two consecutive commands. The occurrence rate of each behavior was 100%, except for the excluded behaviors described in Methods.

**Table 3**

*Two Consecutive Commands, Combined Single Behaviors, and Frequencies*

| First command | Second command | Behaviors | Difference in behavior from original command | Behavioral category in common | Frequencies (%) |
|---|---|---|---|---|---|
| goron | bye-bye | Falling on her left side and lying on her back. Then, swinging both foreflippers. (This behavior is the same behavior indicated by "hakusyu") | Part of her body that was moved | Swinging her foreflipper | 100 |
| goron | keirei | Lying on her back and attaching her palm side of left foreflipper to her nose. (This behavior is the same behavior indicated by "acha-") | The way her joint vended | Touching her right foreflipper to her nose | 100 |
| goron | omawari | Rotating on a horizontal axis with the ground. (This behavior is the same behavior indicated by "kurun") | Axis of rotation | Rotating her body | 100 |
| touritsu | bye-bye | Swinging her hindlimbs while standing upside down. (This behavior is the same behavior indicated by "pan-pan") | Part of her body that was moved | Swinging her flipper | 100 |

*Note.* Each behavior conditioned to each command was shown in Table 1. Frequencies indicate the percentage of each behavior that was calculated for the behaviors targeted for analysis. Videos (from Video 10 to Video 13) show two consecutive commands and behaviors (https://osf.io/shf8c/?view_only=194f41a311034281a776292db999dd28).

## Discussion

### Comprehension of Multiple Linguistic Information with Human Speech

Hama responded to two consecutive commands in a way that corresponded to the two consecutive commands. This suggests that Hama was able to comprehend the multiple linguistic information. In addition, Hama’s responses to two consecutive commands may have the significant potential to lead to advanced linguistic learning (syntactic comprehension).

About 65% of the responses observed in this study were the correct responses indicated by the two consecutive commands in sequence, as shown in Table 2. There was also a pattern of reaction with combined single behaviors as shown in Table 3, but it is considered to be a rare case. We consider that the response pattern of “performing the behaviors indicated by each command in sequence” is the basic response of Hama to the two consecutive commands.

Hama's response of "performing the behaviors indicated by each command in sequence" is similar to the results of the experiment on syntactic comprehension in which multiple cues were given to California sea lions (Schusterman & Gisiner, 1988). We did not specify whether Hama responded to a subject-verb sentence pattern or other sentence patterns, because Hama had learned only the commands that indicate behaviors, that is, verbs. Hama responded to two consecutive verbs in this study, whereas California sea lions in the previous study responded to a subject-verb sentence pattern (Schusterman & Gisiner, 1988). However, the responses of the California sea lions and Steller sea lion (Hama) were similar in that they processed each linguistic information individually and acted accordingly.

While previous studies on California sea lions used hand signals, the present study on a Steller sea lion used human speech as linguistic information. Although the results of the present study were obtained from a single animal, this study indicates that sea lions may be able to understand multiple linguistic information even when human speech, which has different characteristics from hand signals, is used.

As for the command combinations that did not produce the behaviors associated with the two consecutive commands, it was not possible to analyze these causes from the results of this study.

### Spontaneous Category Formation Based on Learned Commands

The behaviors shown in Table 3 that resulted from the two consecutive commands observed in this study were behaviors that were previously associated with other commands that she had learned. In all patterns, the behaviors corresponding to the second command had elements in common with the behavior that was indicated by the command but were different from the correct responses.

These behaviors were spontaneously generated by Hama under the unusual and novel condition of not being able to make a usual response to the command, as a result of the change in her body posture. These behaviors suggest that Hama may have formed categories for the learned commands from her learning experience.

Based on the common element of certain behaviors, Hama may have categorized the learned linguistic information. In other words, these cases show that linguistic information can aggregate referential information, even in non-human animals.

Categories tend to treat multiple objects or events as equivalent (Mervis & Rosch, 1981). The ability of animals to form categories has been investigated in many studies. Pigeons that have been trained to respond to paintings by specific painters were able to select paintings by the reinforced artists, even if the paintings were not in the repertoire that the pigeons had seen (Watanabe et al., 1995). Heffner (1975) showed that dogs can discriminate between the vocalizations of dogs and those of other animals. Parr et al. (2008) conducted an experiment with chimpanzees using a computerized matching-to-sample task, and the chimpanzees could accurately identify the facial expressions of their species.

However, all of these previous studies have used photographs, paintings, and objects, with few reports of cases using linguistic information. Pilley and Reid (2010) reported that Chaser, a border collie dog that had learned proper nouns understood that all objects that could be played with are collectively referred to by the common noun "toy," of which spherical objects are referred to by the common noun "ball," and disk-shaped objects are referred to by the common noun "frisbee." In this case, the categories were formed through a process in which the experimenter presented Chaser with exemplary objects representing each category and conditioned their association with each common noun. This process was clearly different from the case of Hama, where the categories were formed spontaneously. This fact is peculiar to Hama, who formed categories on the basis of learned linguistic information.

**Spontaneous Expression of Learned Behaviors**

The combined single behaviors shown in Table 3 may appear to be phenomena where behaviors are generated in the context of performing the second behavior while performing the first behavior, resulting in a coincidental generation of the same behavior as the existing other behavior. If the combination of the correct responses indicated by the two consecutive commands resulted in different behaviors, the reason that these combined single behaviors were generated could be explained as described above. However, as shown in the immediate previous section, Hama responded by changing the behavior indicated by the command to a different behavior generating combined single behaviors. This result indicates that the combined single behaviors were not randomly generated by a combination of the two consecutive commands but were intentionally generated by Hama.

It may be that Hama recognized the behaviors indicated by the commands that she recently learned (e.g., "acha-," "hakushyu," "kurun," and "pan-pan;" see Tables 1 and 3) by using behaviors indicated by the commands that she had learned in the early stages of her training (i.e., "bye-bye," "goron," "keirei", "omawari," and "toritsu;" see Tables 1 and 3).

We did not use induction with commands that she had learned in the early stages of her learning to condition the behaviors exhibited by commands that she recently learned. This fact indicates that Hama spontaneously established the relationship between the behaviors indicated by these commands that she recently learned and the behaviors indicated by the commands that she had learned during the early stages of her training after learning the commands that she recently learned. As a result, Hama spontaneously expressed behaviors using learned linguistic information, performing commands that she recently learned through commands that she had learned in the early stages of her training.

There have been reports of chimpanzees spontaneously expressing a novel event in a language taught to them. A female chimpanzee, Washoe, spontaneously used a combination of sign language expressions that had been taught to her to name something she was seeing for the first time (Gardner & Gardner, 1969). Gardner and Gardner (1969) called this finding "naming" and reported that Washoe could use the language she had learned when presented with new objects.

While Washoe associates signs with events, Hama associates commands with behaviors. The Washoe case is that of productive language (Herman, 1988), which produces language comprehension by having the animal generate language herself using sign language. By contrast, the Hama case uses receptive language (Herman, 1988), which examines language comprehension by observing how Hama responds to linguistic information (human vocal commands) presented by the trainer. Furthermore, Hama represented events that had already been learned, while Washoe represented something novel (Gardner & Gardner, 1969).

However, there is a similarity between the two cases in that the animals themselves were expressing different events using the linguistic information they had learned. If each sign that Washoe learned from humans was the name of an object, then each command that Hama learned from humans was in a way the name of a behavior. Taken together, this result suggests that the phenomenon observed in Hama is very similar to the "naming" phenomenon observed in Washoe.

There are no reported cases of animals expressing events on their own except in the case of Washoe. In addition, it is an unprecedented discovery that Washoe used language to express objects, whereas Hama used language to express behaviors. This is because Hama has only learned commands that indicate behaviors. In the future, as Hama learns to associate objects with commands, she may be able to represent objects as Washoe does.

**Hama's Ability to Understand Language**

In Sasaki et al. (2022), we characterized each vocal command as a meaningless word that acts as a discriminative stimulus that can indicate a specific behavior but have no meaning in itself. However, Hama created meanings for herself from commands that are meaningless words.

A previous study of dolphins reported findings of creativity, which is called "Innovate." "Innovate" is defined as producing a single behavior different from a previous response, and producing a completely novel and never-before-seen behavior (Dudzinski et al., 2018). The previous study suggests that "Innovate" is the adaptability to changing environments, problem-solving, flexibility, and behavioral ingenuity. Hama's spontaneous responses to two consecutive commands may include elements of creativity in animals.

The behavior of Hama observed in this study suggests that the Steller sea lion may not only learn to associate linguistic information in the form of commands with specific behaviors but may also be capable of "creative language use," in which the animal creates categories for herself and generates new expressions based on linguistic information.

**Study Limitations and Future Directions**

This case study involves at least five limitations. First, we have given two consecutive commands together to Hama for the first time. Therefore, the commands used in the experiment were limited to the five commands most familiar to Hama, and only two consecutive commands were given at a time.

Second, we did not examine whether Hama responds to a subject-verb sentence pattern and other sentence patterns in this study, because the commands that Hama had already learned only indicated behaviors, that is, verbs.

Third, in the present study, when two consecutive commands were given, Hama's initial movement was observed during the giving of the two consecutive commands. So, we could not restrict Hama from responding until the two consecutive commands were given.

Fourth, we did not keep records of specific responses regarding excluded behaviors. In the future, we need to keep records of all behaviors for more detailed analysis.

Fifth, we need to examine the causes of the command combinations and the responses to violate the exclusion criteria (see Methods of Evaluations to Responses). If researchers can overcome these limitations in the future, this case study may be more developed. Although this study is a preliminary study, Hama's responses to two consecutive commands have the significant potential to lead to advanced linguistic learning, such as syntactic comprehension.

## Conclusion

In conclusion, this study is the first case report to examine Steller sea lion's responses to two consecutive commands. Except for exclusion criteria, more than half of the responses showed the correct behaviors associated with the two consecutive commands, specifically two consecutive commands induced combined single behaviors that merged the behaviors indicated by the two consecutive commands and that were already connected to different single commands. The specific two consecutive commands were rare cases in all the responses. However, the specific two consecutive commands were certain to induce the specifically combined single behaviors.

In addition, although the combined single behaviors were not simple combinations of behaviors induced by the two consecutive commands, the combined single behaviors included the common body parts (e.g., foreflippers) or common action types (e.g., rotation) of behaviors induced by each command in the two consecutive commands. This case study suggests that whereas the Steller sea lion could understand multiple linguistic information, she spontaneously shaped categories based on the learned commands.

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