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Inter-Individual Social Exchanges in a Group of *Ex Situ* Killer Whales

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Abstract – Although knowledge about killer whale (*Orcinus orca*) distribution, population structure, and foraging habits is quite extensive, data regarding their social behaviors, inter-individual exchanges, or relationship building and maintenance are critically lacking. This shortage can be partially explained by the challenges of observing such behaviors in the wild, thus managed care (*ex situ*) facilities offer a unique vantage to see inter-individual exchanges in greater detail. Here, we preliminarily examine the social behaviors of 8 *ex situ* killer whales from the surface perspective using scan sample data from a long-term study. Each behavior (e.g., cross swims, pair swims, object play, beak-to-genital interactions) was classified into three identified social subcategories (interaction, duo swim, group swim) and detailed descriptions for some inter-individual exchanges observed are provided. The goal of this paper is to provide a basis for future studies on killer whale social interactions, putting our observations into perspective for what is known about killer whales but also for other delphinid species as similar data for in situ killer whale are not yet available. Thus, a direct comparison between in situ and ex situ observations is not provided here but will be the focus of a future paper. Our results highlight the paucity of data on killer whale social exchanges and the importance of longitudinal studies of both *ex situ* and *in situ* populations to better understand the intricacies of killer whale societies specifically and delphinids more generally.

Keywords – Killer whale, *Orcinus orca*, Social behavior, Sociality, Individual interactions, Managed care

Found in all oceans and most seas, killer whales (*Orcinus orca*) are generally categorized by their foraging ecology and distribution (i.e., ecotype, de Bruyn et al., 2013) with details regarding their morphology and genetics augmenting these descriptions (Morin et al., 2024). The crypticity of the species, i.e., living in vast environments with low underwater visibility that are challenging for humans to conduct studies, has long restricted research topics to what was visible from surface observations only. Thus, while the literature is extensive for killer whale distribution (Baird & Whitehead, 2000; Ford & Ellis, 1999; Jourdain et al., 2019), habitat use (Bigg et al., 1990; Matkin et al., 2014), social structure (Bigg et al., 1990; Esteban et al., 2016; Filatova et al., 2026; Ford et al., 2000; Hoelzel et al., 2007; Jordaan et al., 2021; Tosh et al., 2008), group activity (Heimlich-Boran, 1986; Jourdain et al., 2017; Weiss et al., 2021), and foraging strategies (Baird & Dill, 1996; Beck et al., 2012; Guinet, 1991), much less information is available on the behavioral repertoire(s) or detailed activity budgets of the species (Jacobsen, 1986; Martinez & Klinghammer, 1978). More recently, the development of technology (unmanned aerial vehicles and animal-

born tags) has facilitated scientific research and provided new vantage points; however, these technologies have not been incorporated extensively to study inter-individual social exchanges between killer whales (with one exception: Weiss et al., 2021). Additionally, killer whale social behavior – as groups or individuals – has, historically, been reported rarely in the literature (e.g., Jacobsen, 1990; Martinez & Klinghammer, 1969, 1978; Osborne, 1986; Weiss et al., 2021). Moreover, the social structures of the different populations are also still unclear, though this topic is steadily gaining interest in the recent decade.

Because their coastal distribution and seasonal site fidelity offered relatively easy access via boat- and land-based observations, studies of the North Pacific resident killer whales contributed significantly to early work on this species (e.g., Baird & Dill, 1995, 1996; Bigg et al., 1990; Ford & Ellis, 1999). Much information was gleaned regarding their movement patterns, acoustic behavior, and matrilineal societies (e.g., Dahlheim et al., 2008; Ford, 1989). The long-held assumption that all killer whale populations exhibited stable matrilineal structure is being challenged by recently published results from research with remote populations. Transients, or Bigg's killer whales, although sympatric with resident populations, show a much different social structure displaying smaller group sizes and some degree of dispersal in females (Baird & Whitehead, 2000; Ford & Ellis, 1999). Marion Island killer whales reside in stable social units that include non-related individuals but also have some fission-fusion dynamic over short-term periods (Reisinger et al., 2017). Jourdain et al. (2024) confirmed that although killer whales in Norway could display different foraging strategies (fish-diet vs. mixed diet), these individuals were part of the same social network driven by kinship; however, like the animals around Marion Island, flexible associations within and between social units were documented. Research in other regions has supported the observed and documented variability in identified ecotypes and suggests that this variability may be evident in killer whale sociality (Athayde et al., 2023; Ivkovich et al., 2010).

One way to study social structure is to look at association patterns. Much has been done on North Pacific resident killer whale groups (e.g., Ellis et al., 2017; Ellis et al., 2021; Heimlich-Boran, 1986; Parsons et al., 2009; Weiss et al., 2021). As for other delphinids (Dudzinski, 1996; Gibson & Mann, 2008; Herzing & Brunnick, 1997), associations in killer whales were confirmed as not random with the mother-calf association most consistent with the highest association index (Baird & Whitehead, 2000; Bigg et al., 1990; Heimlich-Boran, 1986). Recently, Ellis and colleagues (Ellis et al., 2017; Ellis et al., 2021) showed there are differences between sons and daughters in their association with their mother. Although both sexes are philopatric, the mother-son association remains stable whereas the mother-daughter association decreases when the daughter has her first calf, but not when the mother has another calf (Ellis et al., 2021). While understanding association patterns is crucial for comprehending animal relationships and their implications for group living, it may not be the most suitable method for grasping the intricacies of killer whale social dynamics. In their work comparing interaction and association networks of southern residents, Weiss et al. (2021) found that factors influencing an association network were different from those affecting an interaction network, though both networks were correlated. This was the first *in situ* study to use a specific type of inter-individual social exchanges (i.e., physical contact) to study these animals. Most social behavior research on *in situ* populations is based on general group actions, i.e., behaviors performed by most individuals in a group (Ford, 1989; Noren & Hauser, 2016), which impedes with our ability to comprehend inter-killer whale social behavior exchanges within a group and masks the processes or mechanisms by which these animals manage their relationships.

With only two published accounts of killer whale behavioral repertoires available, there is a paucity of published details about specific behavioral exchanges between individual killer whales. Martinez and Klinghammer (1978) and Jacobsen (1986) provided details about killer whale inter-individual behavioral exchanges and included partial ethograms from observations of both *in situ* and *ex situ* killer whales. Martinez and Klinghammer's ethogram included complete definitions and context for behaviors observed from individuals and interacting animals. Jacobsen based his ethogram on in situ killer whale behaviors and compared his findings with Martinez and Klinghammer's descriptions. The few differences between these two ethograms might be explained by challenges in observing individual interactions from the surface in the wild rather than actual *in situ vs. ex situ* differences, especially since some of these behaviors have been

documented in in situ populations more recently (Almunia et al., 2025; Grimes et al., 2022; Robeck at al., 2019; Van Weelden et al., 2025; Visser, 1998; D. Bouma, personal communication, March 2025).

The critical lack of literature on killer whale inter-animal interactions makes baseline comparisons nearly impossible currently. Only two papers have examined dyadic exchanges in killer whales – one an *ex situ* group (Sánchez–Hernández et al., 2019) and the other a critically endangered, small *in situ* population (Weiss et al., 2021). Sánchez–Hernández et al. (2019) highlighted the importance of inter-animal interactions to better manage killer whales in controlled environments. Weiss et al. (2021), using drones, compared association and interaction networks using contact exchanges with evident differences in the two networks based on killer whale age and sex, which supports the notion that males and females socialize differently. This void in the literature about inter-individual dyadic behavior exchanges offers a wide platform for research to augment our understanding about how killer whales build and manage their relationships.

Although criticized for small sample sizes, studies of *ex situ* killer whales offer unparalleled insight at the individual level, provide non-invasive opportunities to examine behavior precisely, improve our understanding of subtle intricacies in their behavioral interactions, and allow experimental control that might infer causality (e.g., Asper et al. 1988; Clark & Odell, 1999a, 1999b; Guarino et al., 2016; Martinez & Klinghammer, 1978; Sánchez-Hernández et al., 2019). *Ex situ* facilities offer opportunities to study inter-individual interactions from both surface and underwater perspectives; however, relatively few studies have been conducted on *ex situ* killer whales. The current misconception that behavioral exchanges within ex situ dyads, for any species, do not equate to those shared by wild counterparts is one potential explanation. Yet, the scientific literature available suggests the opposite, with direct comparisons of behaviors shared within ex situ dyads (in artificial habitats and natural lagoons) with those in the wild not showing significant differences in social interactions or their expressed behaviors (Dudzinski, 2010; Dudzinski et al., 2009, 2012, 2013; Dudzinski & Ribic, 2017; Greene et al., 2011; Themelin et al., 2020). Such detailed information is currently not available for comparison to in situ killer whale populations. Anecdotal observations suggest more similarities than differences in how both in situ and ex situ killer whale pairs share behaviors (Almunia et al., 2025; Martinez & Klinghammer, 1978). Thus, studying inter-individual interactions in ex situ killer whales could help shed light on the intricacies of their social behaviors while also developing protocols for in situ population studies similar to research with other species (Aoki et al., 2021; Dudzinski, 2010; Dudzinski et al., 2010; Morisaka et al., 2010; Vergara et al., 2010).

In this note, we present details about inter-individual interactions of *ex situ* killer whales at SeaWorld California (SWC). First, we provide an overview of their social behavior using three subcategories and then describe and discuss interactions and behaviors documented between and among individuals of this group. Then, we set these observations into the context of what is known for killer whale behavior overall without providing a detailed direct comparison between both settings because of the lack of comparable data for in situ populations. Thus, our goal is to foster increased general knowledge of killer whale social and inter-individual behaviors from the *ex situ* perspective to provide a detailed ethogram of interactions between individuals.

Data presented here were collected as part of an ongoing study at SWC started in April 2022 (Manitzas Hill et al., 2025). The study group included three adult males (ULY, KEE, IKA), a juvenile male (MAK), and four adult females (COR, ORK, SHO, KAL). COR was the only post-reproductive female. NAK was present only in April and June 2022. All other individuals were present from April 2022 to January 2023. NAK, MAK, and KAL are siblings. The training team managed the daily social grouping based on animal preferences and care practices, with group size varying from 1 to 6 individuals, though groups of 1 were not observed more than 10 scans during the study (Manitzas Hill et al., 2025).

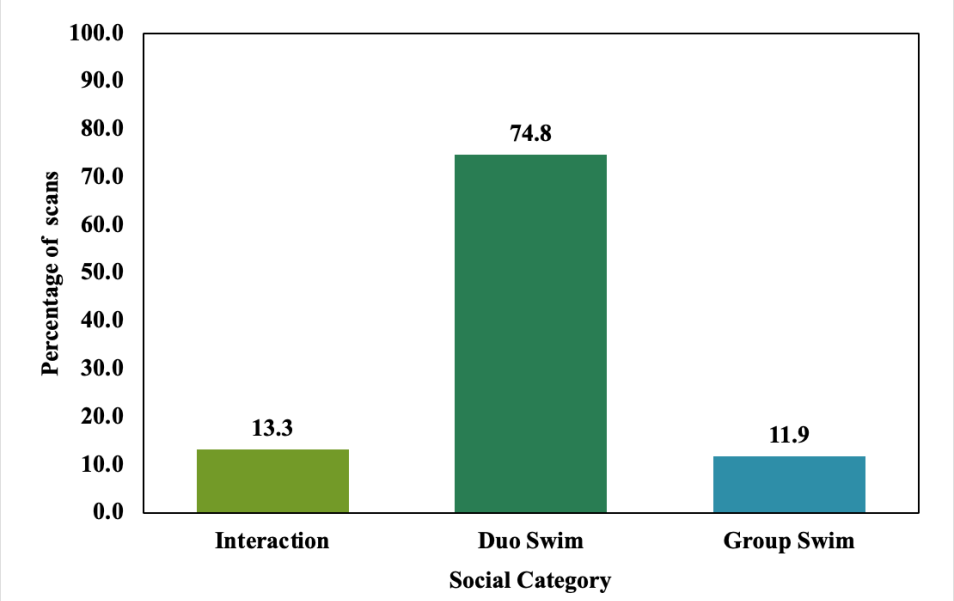
Details about this five-pool facility (24,605 m^3) and the video data exports and processing can be found in Manitzas Hill et al. (2025). Each pool had an overhead camera totaling 8-10 camera angles allowing full coverage of the facility; 72 h of day-time videos were exported every two months for all pools (See Figure 1 and Table 2 in Manitzas Hill et al., 2025). For this study, 1,843 h of video were exported, and 311.7 h were analyzed following a scan sample protocol using BORIS (version 7.13.9, Friard & Gamba, 2016). All video data were processed as described in Manitzas Hill et al. (2025). In brief, 10 min

observations were conducted for each pool at the same time every hour from 06:00 to 20:00 (i.e., after sunrise and before sunset), recording behaviors at the top of each minute (i.e., scan) for each individual. Observations started before and ended after trainers were present on site, though during presence time they were not always visible to the animals outside of training sessions. The original study used 10 behavioral categories to record behaviors during scans (see Table 3 in Manitzas Hill et al., 2025 for definitions), though for this short note, we focus specifically on behaviors included in the "Social" behavioral category of Manitzas Hill et al. (2025). Various inter-individual interactions were observed, though to better represent this group's general social behaviors, three behavioral subcategories were created: interaction, duo swims, group swims. Interactions were recorded when two or more killer whales directed behavior to each other (e.g., tactile contact, circle swims, object play). Duo swims were defined as two individuals swimming within an adult female body length of each other in the same direction whereas group swims included three or more animals swimming in the same direction together (i.e., within an adult female body length).

Over the 261 hours of coded videos and 241 10-min observations (i.e., 2,410 scans), a total of 20,150 entries were recorded (one entry per individual per scan). We recorded 1,053 social events (i.e., 1 social event equaled 2+ killer whales engaged in any defined subcategory) with 140 interactions, 788 duo swims, and 125 group swims recorded (Figure 1). The three subcategories were represented in 36.7% of the scans (N = 884 over 2,410). Examining the 241 10-min observations, 65.6% included at least one subcategory (N = 158). As most studies focusing on wild populations reported "group resting" (i.e., slow group activity either swimming slowly or completely stationary; e.g., Noren & Hauser, 2016), we also calculated the same proportions including resting in proximity of other individual as an additional social subcategory: 59.2% of the scans (N = 1,427) were social, which corresponded to 88.4% (N = 213) of all 10-minute observations.

Figure 1

Distribution of the Social Behavior Subcategories Exhibited by the SeaWorld California Killer Whales



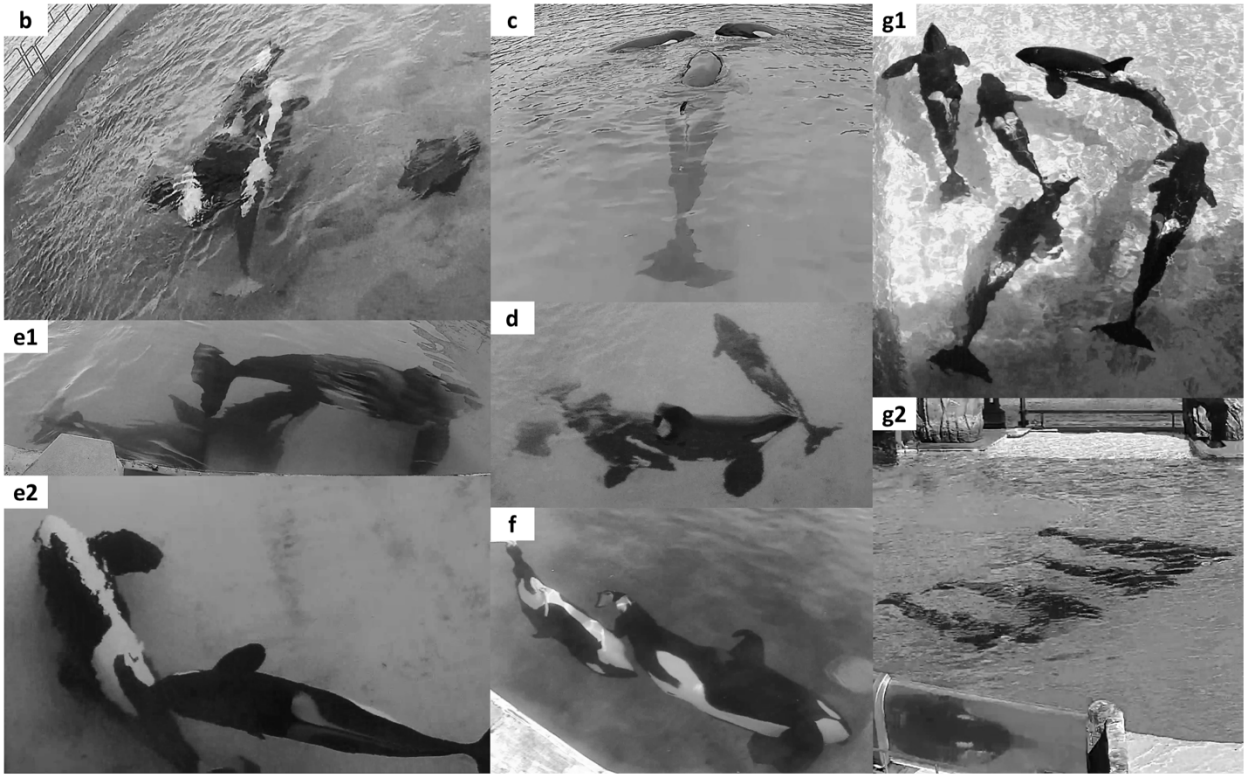
Our goal was to provide a description of the inter-individual social behaviors documented at SWC. These descriptions are not presented for frequency of observation but to describe and place into the context of what is known (and presented in the published literature) for killer whale behavior. Each of the described observations fell into one of the three identified social subcategories (Figure 1). Basic quantitative summaries describing the proportion of time each individual killer whale engaged in these subcategories are provided in supplemental material (Figure S1 and Table S1). Additional details regarding date, scan

time (i.e., observation period), and specific killer whales involved in each described behavior are provided in supplemental material (Table S2).

a) On at least two occasions, an adult female swam slowly to a resting adult male on the side of the pool and pushed him gently on the side with the rostrum (Table S2). On both occasions, this behavior was followed by both individuals starting to swim together.
b) A "cross-swimming" behavior was observed on several occasions (Figure 2b, Table S2). This behavior might be similar to what Martinez and Klinghammer (1978) described as "high speed brushing". Here, we defined this behavior as two killer whales swimming toward each other head-to-head but turning their heads at the last second to pass each other (i.e., cross-swimming past each other), their bodies made contact on the flanks in a long, deep rub ("brushing") exchange, sometimes their bodies bounced on one another. This behavior was initiated by either one or both individuals, i.e., only one killer whale swam toward the other or the two killer whales swam toward each other. On most occasions, this behavior was repeated with individuals looking at each other and re-positioning themselves as they approached one another again. Based on our observations and previous descriptions, this behavior was believed to be play between individuals.
c) On one occasion, one of the females caught a bird individually. As soon as she caught it, she moved to the pool's center and closer to the other two females present. All three females positioned their bodies into a star pattern around the dead bird with heads oriented at each other (Figure 2c, Table S2), seemingly pulling the bird apart. This event could be an example of food sharing after a hunt, though the angle of the camera prevented confirmation of bird consumption.
d) Infant position was observed in same-sex dyads and mixed-sex dyads (Figure 2d, Table S2). The youngest male was seen in infant position with two other adult males on several occasions with the mother/calf roles switched. An adult female was also seen in infant position with another adult female. On several occasions, adult males and females were seen in infant position together with either sex in the mother or calf role.
e) A beak-to-genital behavior (i.e., individual putting its rostrum close/in contact with another individual's genital slit, Figure 2e, Table S2) was observed on three occasions. On the first occasion, two males were swimming in infant position, and the individual below put its rostrum toward the genital slit of the upper male. On the two other occasions, an adult male swam on his left side when an adult female approached him slowly; she swam along his body and put her rostrum in close proximity to his genital slit.
f) Socio-sexual interactions between males were observed on several occasions, with each male either mounting one another or swimming together with either penis out (i.e., not fully erect but visible, Figure 2f, Table S2).
g) On several occasions, group swims of three and four killer whales were observed with all animals lined up and each individual parallel to one another (either perfectly or slightly staggered, (Figure 2g, Table S2)). These swims could last one circle swim in a pool or a full 10-min observation period. In most cases, all animals were synchronous in their surfacing/breathing. An observation of a group of five killer whales swimming together was also made, although individual positioning was not in line across animals but more grouped together in small dyads.

Figure 2

Examples of Various Behaviors and Interactions Between and Among the SeaWorld California Killer Whales Described in the Text



Note. Letters per image pair to the list of behaviors described: b) cross swimming, c) potential bird sharing, d) infant position, e1) beak-to-genital between males during infant position, e2) beak-to-genital from a female to a male, f) socio-sexual behavior between males, g1) group swim with five individuals, g2) group swim with four individuals lined-up.

We provide one of the first detailed descriptions of individual killer whale behaviors and exchanges between and among individual animals. All individuals in this group were observed to interact with other group members in various ways. All individuals engaged in duo swims that included various pair swims and tactile exchanges as well as inquisitive, play behaviors, and other shared actions exhibited during group swims. These detailed descriptions of killer whale social behavior are sparse in the literature. Only Martinez and Klinghammer (1978) and Jacobsen (1986) presented inter-individual killer whale behavior interactions and comparisons for both in situ and ex situ killer whales, suggesting more similarity between both settings. The inter-individual behavioral exchanges observed in our study align with their early work but also compare to what has been observed in other dolphin species. For example, Martinez and Klinghammer (1978) described a behavior they called “high speed brushing”, which is similar to the “cross-swimming” behavior we observed. Our results support their interpretation of cross-swims as a play behavior. Descriptively, the two individuals involved seem to “re-position” each other, angling their heads toward each other before swimming at each other. They glide over each other’s bodies before mutually turning and repeating the actions. This behavior involves body-to-body rubbing and reciprocity from both partners that each seem to wait for the other to be in position before cross-swimming each other again. This pattern suggests this behavior could be some kind of game. Cross-swims have also been observed in bottlenose dolphins (*Tursiops truncatus*) (DCP, unpublished data, 2020-2024) of various ages, generally involving males, with the same kind of reciprocity and game-like components during playful contexts (e.g., Greene

et al., 2011). Although games might be difficult to identify in animals, Manitzas Hill et al. (2023) found evidence that belugas (*Delphinapterus leucas*) developed social games following a certain set of rules.

While play often involves much tactile contact between partners, physical contact between individuals also happens during other types of social behaviors like pair swimming positions (Duda, et al., 2024; Themelin & Dudzinski, 2025). Although the killer whales in this study were observed in duo and group swims with individuals close enough to be in contact, no physical contacts were documented, which could be an artefact of our study setting with observations made from the surface perspective only. The above-water vantage prevented confirmation of physical contacts because of water movement, distortion, and surface glare. Recent underwater observations of this group confirmed inter-individual physical contacts, including complex pectoral fin contact exchanges (Themelin et al., 2025), as seen in other delphinid species. Bottlenose dolphins (*Tursiops* sp.) use pectoral fin contacts to establish, strengthen, and maintain social bonds (Connor et al., 2006; Dudzinski et al., 2010; Dudzinski & Ribic, 2017), for reconciliation and tension reduction (Sakai et al., 2006; Tamaki et al., 2006; Yamamoto & Kashiwagi, 2023), but also for discipline (Dudzinski et al., 2021) with calves likely learning when and how to use this behavior appropriately (Duda et al., 2024). Pectoral fin contact is considered a conserved behavior across odontocetes with several species using this behavior during social interactions (e.g., Atlantic spotted (*Stenella frontalis*) and bottlenose dolphins: Dudzinski et al., 2012; Dudzinski et al., 2009, 2017; pilot whales (*Globicephala melas*): Aoki et al., 2013; Hofman et al., 2004; Commerson's dolphins (*Cephalorhynchus commersonii*): Johnson & Moewe, 1999; belugas: Hill et al., 2016; Hill et al., 2018). Thus, it would stand to reason that, as the largest dolphin species, killer whales also use this behavior socially. These contact exchanges are being investigated in greater detail in our ongoing, longitudinal study of killer whales, and will be included in future papers.

Another behavior documented in this study and not previously described for killer whales but much documented for smaller dolphins (e.g., Dudzinski, 1998; Mann & Smuts, 1999) is beak-to-genital contact: one individual's rostrum makes contact with a second animal's genital area while swimming. Although here this behavior was observed between males and from an adult female to an adult male, beak-to-genital has involved both sexes in each role and across all age ranges (calf to adult) in other species. Many independent functions have been proposed for this behavior, including socio-sexual contexts (Dudzinski, 1998; Ham et al., 2023a, b) or inter-individual communication of various inner states (e.g., reproductive, health, etc., Bruck et al., 2022). Indeed, dolphins have taste receptors (Nachtigall, 1986) that suggest they might detect chemical cues to identify reproductive status of a potential partner. Bruck et al. (2022) confirmed that bottlenose dolphin urine has an individual cue that pairs with their signature whistle, suggesting beak-to-genital might have more functions than previously expected that might be context dependent. It is yet unknown how killer whales might use this behavior, though no socio-sexual context was identified during our observations.

Whereas pair swimming positions were observed for these killer whales, including infant, parallel, and staggered parallel positions (Themelin & Dudzinski, 2025), the surface perspective prevented confirmation of positioning between partners in most events. This precluded a detailed investigation of pair swimming use for killer whales as compared to smaller dolphins (Themelin et al., 2020; Themelin & Dudzinski, 2025), though two more broadly defined swim patterns (i.e., duo swim and group swim) were examined. Overall, duo swims were more observed than group swims (and interactions) in our study group (for details, see Themelin et al., 2026). Males were involved in this behavior more than females, whereas females were observed more in group swims than males. These patterns suggest that males were more inclined to take part in dyadic social (pair) swims whereas females engaged more in group social events, thus examination of sex combinations of individuals warrants further investigation.

Because of age homogeneity in our study group, mostly represented by adults and a single juvenile, the effect of age was not investigated, though some observations suggest age could play a role in our results. Anecdotally, the two older females and the oldest male were less social than the other individuals, which is similar to findings from Weiss et al. (2021) and primate studies (including humans) showing that sociality decreases with age (Machanda & Rosati, 2020; Schroeder et al., 2024; Wrzus et al., 2013). Along with age, individual variability observed also might be explained by differences in personality traits between

individuals. Several studies have confirmed that individuals of both large (Úbeda et al., 2019; Úbeda et al. 2021) and small (Highfill & Kuczaj, 2007; Morton et al., 2021) delphinids have distinct and stable personalities, which suggests that individual variability might be more of a driving factor in their societies than other traits such as age and sex.

In more than 260 hours of video analyses, only one agonistic interaction event was recorded and involved principally two individuals. Interestingly, these two individuals were part of the strongest dyads in this group (Themelin et al., 2026). As relationships are built based on the nature, frequency, and consistency of interactions between two individuals over time (Hinde, 1976), this agonistic event shows how inter-individual interactions can fluctuate daily and that all interactions do not have to be affiliative for a relationship to be positive (e.g., Themelin et al., 2020). Also, relationships are rarely symmetrical, and including initiator and receiver roles of social events in future studies will help better understand and define the quality of the relationships observed in this killer whale group. Additionally, this event highlighted another important aspect of inter-individual behaviors in killer whales, post-conflict management. After this agonistic event ended, two preferred associates (Themelin et al., 2026) of one of the individuals involved initiated a group swim with it, leading to all three swimming at a strong pace first and then quickly slowing. This observation supports a proposed hypothesis for pair/group swims to function as a tension relief mechanism (Themelin et al., 2025; Themelin & Dudzinski, 2025), which is consistent with Sánchez-Hernández et al. (2019) in their observation of post-conflict reconciliation patterns in killer whales using physical contact after agonistic interactions. Both observations (Sánchez-Hernández et al. and ours) show that killer whales might be similar to bottlenose dolphins in the way they manage agonistic interactions (Tamaki et al., 2006; Yamamoto & Kashiwagi, 2023). A more detailed investigation of the affiliative and agonistic interactions of killer whales is needed to better understand post-conflict management in this species.

Our observations and assessment of individual interactions, pair swims, and placement between individuals were conducted only from surface video, which likely impacted our ability to clearly see actions between individuals because of sun angle and glare, amount of daylight, and distortion caused by surface tension. Also, animal movement often caused surface water displacement shrouding social events making their assessment challenging. Observations from above the water surface obscured the positioning of each dyad's partner on a 3D axis that impeded confirmation of pair swim positions (Themelin & Dudzinski, 2025). For these reasons, assessing and counting behavioral exchanges between killer whales via a scan sample protocol across 10-minute observation periods during daylight hours likely underestimated the level social interactions for these killer whales. These impediments to behavioral observations have been resolved in our ongoing, longitudinal study with the addition of underwater video to augment the visibility and recording of inter-individual exchanges. This added perspective already has provided greater insight into killer whale physical contact exchanges (Themelin et al., 2025) and will offer knowledge to better understand killer whale social exchanges generally.

Although similar data and observations for in situ killer whales are lacking currently, preventing direct comparisons with our study, our observations facilitated a better understanding of the inter-individual social exchanges in our group of ex situ killer whales. The single agonistic event observed, along with the many affiliative interactions (including pectoral fin contacts, Themelin et al., 2025), suggests a healthy group dynamic with inter-individual relationships well managed and supported by the husbandry team. While more is still to be learned, this preliminary examination has informed the next phase of our study examining inter-individual interactions from the underwater perspective. Despite methodological discrepancies between this *ex situ* study compared to other in situ research, some behavioral similarities were observed, which will be explored in the future. We will expand this study to also include other ex situ killer whale groups (to diversify our age categories) as well as underwater and drone observations of in situ killer whales, to allow direct comparison between both settings. This research supports the importance of ex situ observations to better understand phenomena not readily observable in wild counterparts. And finally, our research further highlights the importance of longitudinal studies not only for in situ populations but also for ex situ groups to better identify the intricacies of cetacean sociality.

Ethics Statement

Approval to conduct this study was granted by the SeaWorld Parks Animal Research Use Committee. Video data were collected in a non-invasive manner from cameras mounted above each pool that did not influence animal actions, interactions, or behavior. All coding analyses were from video data only.

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References

Almunia, J., Van Vliet, J., & Bouma, D. (2025). A kiss from the wild: Tongue nibbling in free-ranging killer whales (*Orcinus orca*). *Oceans*, *6*(2), 37. https://doi.org/10.3390/oceans6020037

Aoki, K., Watanabe, Y., Inamori, D., Funasaka, N., & Sakamoto, K. Q. (2021). Towards non-invasive heart rate monitoring in free-ranging cetaceans: A unipolar suction cup tag measured the heart rate of trained Risso's dolphins. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *376*(1831), 20200225. https://doi.org/10.1098/rstb.2020.0225

Asper, E. D., Young, G. W., & Walsh, M. T. (1988). Observations on the birth and development of a captive-born killer whale. *International Zoo Yearbook*, *27*(1), 295–304. https://doi.org/10.1111/j.1748-1090.1988.tb03227.x

Baird, R. W., & Dill, L. M. (1995). Occurrence and behaviour of transient killer whales: Seasonal and pod-specific variability, foraging behaviour, and prey handling. *Canadian Journal of Zoology*, *73*(7), 1300–1311. https://doi.org/10.1139/z95-154

Baird, R. W., & Dill, L. M. (1996). Ecological and social determinants of group size in *transient* killer whales. *Behavioral Ecology*, *7*(4), 408–416. https://doi.org/10.1093/beheco/7.4.408

Baird, R. W., & Whitehead, H. (2000). Social organization of mammal-eating killer whales: Group stability and dispersal patterns. *Canadian Journal of Zoology*, *78*(12), 2096–2105. https://doi.org/10.1139/z00-155

Bigg, M. A., Olesiuk, P. F., & Ellis, G. M. (1990). Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. *Report of the International Whaling Commission*, *12*.

Bruck, J. N., Walmsley, S. F., & Janik, V. M. (2022). Cross-modal perception of identity by sound and taste in bottlenose dolphins. *Science Advances*, *8*(20), eabm7684. https://doi.org/10.1126/sciadv.abm7684

Clark, S. T., & Odell, D. K. (1999a). Nursing parameters in captive killer whales (*Orcinus orca*). *Zoo Biology: Published in affiliation with the American Zoo and Aquarium Association*, *18*(5), 373–384. https://doi.org/10.1002/(SICI)1098-2361(1999)18:5<373::AID-ZOO2>3.0.CO;2-D

Clark, S. T., & Odell, D. K. (1999b). Allometric relationships and sexual dimorphism in captive killer whales (*Orcinus orca*). *Journal of Mammalogy, 80*(3), 777–785. https://doi.org/10.2307/1383247

Connor, R.C., Mann, J., Watson-Capps, J., 2006. A sex-specific affiliative contact behavior in Indian Ocean bottlenose dolphins, *Tursiops* sp. *Ethology, 112*, 631–638. https://doi.org/10.1111/j.1439-0310.2006.01203.x

Dahlheim, M. E., Schulman-Janiger, A., Black, N., Ternullo, R., Ellifrit, D., & Balcomb III, K. C. (2008). Eastern temperate North Pacific offshore killer whales (*Orcinus orca*): Occurrence, movements, and insights into feeding ecology. *Marine Mammal Science*, *24*(3), 719–729. https://doi.org/10.1111/j.1748-7692.2008.00206.x

de Bruyn, P. J. N., Tosh, C. A., & Terauds, A. (2013). Killer whale ecotypes: Is there a global model? *Biological Reviews*, *88*(1), 62–80. https://doi.org/10.1111/j.1469-185X.2012.00239.x

Dudzinski, K. M. (1996). Communication and behavior in the Atlantic spotted dolphin *(Stenella frontalis):* Relationships between vocal and behavioral activities. PhD dissertation, Texas A & M University. 215 pp.

Dudzinski, K. M. (1998). Contact behavior and signal exchange in Atlantic spotted dolphins (*Stenella frontalis*). *Aquatic Mammals*, *24*(3), 129–142.

Dudzinski, K. M. (2010). Overlap between information gained from complementary and comparative studies of captive and wild dolphins. *International Journal of Comparative Psychology*, *23*(4), 566–586. https://doi.org/10.46867/IJCP.2010.23.04.13

Dudzinski, K. M., Danaher-Garcìa, N., & Gregg, J. D. (2013). Pectoral fin contact between dolphin dyads at Zoo Duisburg, with comparison to other dolphin study populations. *Aquatic Mammals*, *39*(4), 335–343. https://doi.org/10.1578/AM.39.4.2013.335

Dudzinski, K. M., Gregg, J. D., Melillo-Sweeting, K. E., Seay, B., Levengood, A., & Kuczaj II, S. A. (2012). Tactile contact exchanges between dolphins: Self-rubbing versus inter-individual contact in three species from three geographies. *International Journal of Comparative Psychology*, *25*(1), 21–43. https://doi.org/10.46867/ijcp.2012.25.01.03

Dudzinski, K. M., Gregg, J. D., Paulos, R. D., & Kuczaj, S. A. (2010). A comparison of pectoral fin contact behaviour for three distinct dolphin populations. *Behavioural Processes*, *84*(2), 559–567. https://doi.org/10.1016/j.beproc.2010.02.013

Dudzinski, K. M., Gregg, J. D., Ribic, C. A., & Kuczaj, S. A. (2009). A comparison of pectoral fin contact between two different wild dolphin populations. *Behavioural Processes*, *80*(2), 182–190. https://doi.org/10.1016/j.beproc.2008.11.011

Dudzinski, K. M., & Ribic, C. A. (2017). Pectoral fin contact as a mechanism for social bonding among dolphins. *Animal Behavior and Cognition*, *4*(1), 30–48. https://doi.org/10.12966/abc.03.02.2017

Dudzinski, K. M., Ribic, C. A., Manitzas Hill, H. M., & Bolton, T. T. (2021). Evidence for maternal style among adult female dolphins when sharing pectoral fin contacts with their calves. *Animal Behavior and Cognition*, *8*(1), 52–68. https://doi.org/10.26451/abc.08.01.05.2021

Ellis, S., Franks, D. W., Nattrass, S., Cant, M. A., Weiss, M. N., Giles, D., Balcomb, K. C., & Croft, D. P. (2017). Mortality risk and social network position in resident killer whales: Sex differences and the importance of resource abundance. *Proceedings of the Royal Society B: Biological Sciences*, *284*(1865), 20171313. https://doi.org/10.1098/rspb.2017.1313

Ellis, S., Franks, D. W., Weiss, M. N., Cant, M. A., Domenici, P., Balcomb, K. C., Ellifrit, D. K., & Croft, D. P. (2021). Mixture models as a method for comparative sociality: Social networks and demographic change in resident killer whales. *Behavioral Ecology and Sociobiology*, *75*(4), 75. https://doi.org/10.1007/s00265-021-03006-3

Esteban, R., Verborgh, P., Gauffier, P., Giménez, J., Foote, A. D., & de Stephanis, R. (2016). Maternal kinship and fisheries interaction influence killer whale social structure. *Behavioral Ecology and Sociobiology*, *70*(1), 111–122. https://doi.org/10.1007/s00265-015-2029-3

Filatova, O. A., Fedutin, I. D., & Fomin, S. V. (2026). Predation by mammal-eating Bigg's killer whales (*Orcinus orca rectipinnus*) may shape the unique social structure of "resident" fish-eating killer whales (*O. o. ater*) in the North Pacific. *Marine Mammal Science*, *42*(2), e70142. https://doi.org/10.1111/mms.70142

Ford, J. K. B. (1989). Acoustic behaviour of resident killer whales (*Orcinus orca*) off Vancouver Island, British Columbia. *Canadian Journal of Zoology*, *67*(3), 727–745. https://doi.org/10.1139/z89-105

Ford, J. K. B., & Ellis, G. M. (1999). *Transients: Mammal-hunting killer whales of British Columbia, Washington, and Southeastern Alaska.* UBC Press. https://doi.org/10.1139/z91-206

Ford, J. K. B., Ellis, G. M., & Balcomb, K. C. (2000). *Killer Whales: The natural history and genealogy of Orcinus orca in British Columbia and Washington State, Second Edition.* UBC Press.

Friard, O., & Gamba, M. (2016). BORIS: A free, versatile open-source event-logging software for video/audio coding and live observations. *Methods in Ecology and Evolution*, *7*(11), 1325–1330. https://doi.org/10.1111/2041-210X.12584

Gibson, Q. A., & Mann, J. (2008). The size, composition and function of wild bottlenose dolphin (*Tursiops* sp.) mother-calf groups in Shark Bay, Australia. *Animal Behaviour*, 76(2), 389–405. https://doi.org/10.1016/j.anbehav.2008.01.022

Greene, W. E., Melillo-Sweeting, K., & Dudzinski, K. M. (2011). Comparing object play in captive and wild dolphins. *International Journal of Comparative Psychology*, *24*(3), 292–306. https://doi.org/10.46867/IJCP.2011.24.03.01

Grimes, C., Brent, L. J. N., Weiss, M. N., Franks, D. W., Balcomb, K. C., Ellifrit, D. K., Ellis, S., & Croft, D. P. (2022). The effect of age, sex, and resource abundance on patterns of rake markings in resident killer whales (*Orcinus orca*). *Marine Mammal Science*, *38*(3), 941–958.

Guarino, S., Hill, H. M., & Sigman, J. (2016). Development of sociality and emergence of independence in a killer whale (*Orcinus orca*) calf from birth to 36 months. *Zoo Biology*, *36*(1), 1–10. https://doi.org/10.1002/zoo.21338

Guinet, C. (1991a). Intentional stranding apprenticeship and social play in killer whales (*Orcinus orca*). *Canadian Journal of Zoology*, *69*(11), 2712–2716. https://doi.org/10.1139/z91-383

Guinet, C. (1991b). L'orque (*Orcinus orca*) autour de l'archipel Crozet, comparaison avec d'autres localités. *Revue d'écologie : La Terre et La Vie*, *46*(4), 321–337.

Ham, J. R., Lilley, M. K., Miller, M. R., Leca, J.-B., Pellis, S. M., & Manitzas Hill, H. M. (2023a). Self-handicapping in object play: How belugas (*Delphinapterus leucas*) make play difficult. *International Journal of Play*, *12*(1), 67–80. https://doi.org/10.1080/21594937.2022.2152535

Ham, J. R., Lilley, M. K., & Manitzas Hill, H. M. (2023b) Non-conceptive sexual behavior in cetaceans: comparison of form and function. In B. Würsig, D. N. Orbach (Eds.), *Sex in Cetaceans*. Springer International Publishing, pp. 129–151.

Heimlich-Boran, S. L. (1986). Cohesive relationships among Puget Sound killer whales. In J. C. Kirkevold & J. S. Lockard (Eds.), *Behavioral biology of killer whales*. Arlan R. Liss, Inc., New York, pp. 251–284.

Herzing, D. L., & Brunnick, B. J. (1997). Coefficients of association of reproductively active female Atlantic spotted dolphins, *Stenella frontalis*. *Aquatic Mammals*, *23*(3), 155–162.

Hill, H. M., Guarino, S., Dietrich, S., & St Leger, J. (2016). An inventory of peer-reviewed articles on killer whales (*Orcinus orca*) with a comparison to bottlenose dolphins (*Tursiops truncatus*). *Animal Behavior and Cognition*, *3*(3), 135–149. https://doi.org/10.12966/abc.03.08.2016

Hill, H., Dietrich, S., Jantea, R. F., Garza, S., & Lacy, K. (2018). The Frequency of Contact in Beluga (*Delphinapterus leucas*) Calf Social Interactions. *Aquatic Mammals*, *44*(1), 62–75. https://doi.org/10.1578/AM.44.1.2018.62

Highfill, L. E., & Kuczaj, S. A. (2007). Do bottlenose dolphins (*Tursiops truncatus*) have distinct and stable personalities? *Aquatic mammals*, *33*(3), 380–389. https://doi.org/10.1578/AM.33.3.2007.380

Hinde, R. A., 1976. Interactions, relationships and social structure. *Man*, *11*(1), 1–17.

Hoelzel, A. R., Hey, J., Dahlheim, M. E., Nicholson, C., Burkanov, V., & Black, N. (2007). Evolution of population structure in a highly social top predator, the killer whale. *Molecular Biology and Evolution*, *24*(6), 1407–1415. https://doi.org/10.1093/molbev/msm063

Hofmann, B., Scheer, M., & Behr, I. P. (2004). Underwater behaviors of short-finned pilot whales (*Globicephala macrorhynchus*) off Tenerife. *Mammalia*, *68*(2–3), 221–224. https://doi.org/10.1515/mamm.2004.020

Ivkovich, T., Filatova, O. A., Burdin, A. M., Sato, H., & Hoyt, E. (2010). The social organization of resident-type killer whales (*Orcinus orca*) in Avacha Gulf, Northwest Pacific, as revealed through association patterns and acoustic similarity. *Mammalian Biology - Zeitschrift Für Säugetierkunde*, *75*(3), 198–210. https://doi.org/10.1016/j.mambio.2009.03.006

Jacobsen, J. K. (1986). The behavior of *Orcinus orca* in the Johnstone Strait, British Columbia. In J. C. Kirkevold & J. S. Lockard (Eds.), *Behavioral biology of killer whales*. Arlan R. Liss, Inc., New York, pp. 135–185.

Johnson, C. M., & Moewe, K. (1999). Pectoral fin preference during contact in Commerson's dolphins (*Cephalorhynchus commersonii*). *Aquatic Mammals*, *25*(2), 73–77.

Jordaan, R. K., Reisinger, R. R., Oosthuizen, W. C., & De Bruyn, P. J. N. (2021). Seasonal fission and fusion of killer whale, *Orcinus orca*, social structure at sub-Antarctic Marion Island. *Animal Behaviour*, *177*, 223–230. https://doi.org/10.1016/j.anbehav.2021.05.007

Jourdain, E., Karoliussen, R., Fordyce Martin, S. L., Langangen, Ø., Robeck, T., Borgå, K., Ruus, A., & Foote, A. D. (2024). Social and genetic connectivity despite ecological variation in a killer whale network. *Proceedings of the Royal Society B: Biological Sciences*, *291*(2021), 20240524. https://doi.org/10.1098/rspb.2024.0524

Machanda, Z. P., & Rosati, A. G. (2020). Shifting sociality during primate ageing. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1811), 20190620. https://doi.org/10.1098/rstb.2019.0620

Manitzas Hill, H. M., Ortiz, N., Kolodziej, K., & Ham, J. R. (2023). Social games that belugas (*Delphinapterus leucas*) play. *International Journal of Play*, *12*(1), 81–100. https://doi.org/10.1080/21594937.2022.2152536

Manitzas Hill, H. M., Themelin, M., Dudzinski, K. M., Felice, M., & Robeck, T. (2025). Individual variation in activity budgets of a stable population of killer whales in managed care across a year. *Behavioural Processes*, *224*, 105135. https://doi.org/10.1016/j.beproc.2024.105135

Mann, J., Smuts, B., 1999. Behavioral development in wild bottlenose dolphin newborns (*Tursiops* sp.). *Behaviour, 136*(5), 529–566. https://doi.org/10.1163/156853999501469

Martinez, D. R., & Klinghammer, E. (1978). A partial ethogram of the killer whale (*Orcinus orca* L.). Carnivore, *13*(4), 13–27.

Morin, P. A., McCarthy, M. L., Fung, C. W., Durban, J. W., Parsons, K. M., Perrin, W. F., Taylor, B. L., Jefferson, T. A., & Archer, F. I. (2024). Revised taxonomy of eastern North Pacific killer whales (*Orcinus orca*): Bigg's and resident ecotypes deserve species status. *Royal Society Open Science*, *11*(3), 231368. https://doi.org/10.1098/rsos.231368

Morisaka, T., Kohshima, S., Yoshioka, M., Suzuki, M., & Nakahara, F. (2010). Recent studies on captive cetaceans in Japan: Working in tandem with studies on cetaceans in the wild. *International Journal of Comparative Psychology*, *23*(4). https://doi.org/10.46867/IJCP.2010.23.04.10

Morton, F. B., Robinson, L. M., Brando, S., & Weiss, A. (2021). Personality structure in bottlenose dolphins (*Tursiops truncatus*). *Journal of comparative psychology*, *135*(2), 219–231. https://doi.org/10.1037/com0000259

Nachtigall, P. E. (1986) Vision, audition, and chemoreception in dolphins and other marine mammals. In R. J. Schusterman, J. A. Thomas, F. G. Wood (Eds.), *Dolphin cognition and behavior: A comparative approach*. *Psychology Press*, pp. 79–113.

Noren, D. P. & Hauser, D. W. (2016). Surface-based observations can be used to assess behavior and fine-scale habitat use by an endangered killer whale (*Orcinus orca*) population. *Aquatic Mammals*, *42*(2), 168–183. https://doi.org/10.1578/AM.42.2.2016.168

Osborne, R. W. (1986). A behavioral budget of Puget Sound killer whales. In J. C. Kirkevold & J. S. Lockard (Eds.), *Behavioral biology of killer whales*. Arlan R. Liss, Inc., New York, pp. 211–249.

Parsons, K. M., Balcomb, K. C., Ford, J. K. B., & Durban, J. W. (2009). The social dynamics of southern resident killer whales and conservation implications for this endangered population. *Animal Behaviour*, *77*(4), 963–971. https://doi.org/10.1016/j.anbehav.2009.01.018

Reisinger, R. R., Beukes (née Janse van Rensburg), C., Hoelzel, A. R., & de Bruyn, P. J. N. (2017). Kinship and association in a highly social apex predator population, killer whales at Marion Island. *Behavioral Ecology*, *28*(3), 750–759. https://doi.org/10.1093/beheco/arx034

Robeck, T. R., St. Leger, J. A., Robeck, H. E., Nilson, E., & Dold, C. (2019). Evidence of variable agonistic behavior in killer whales (*Orcinus orca*) based on age, sex, and ecotype. *Aquatic Mammals*, *45*(4), 430–446.

Sakai, M., Hishii, T., Takeda, S., & Kohshima, S. (2006). Flipper rubbing behaviors in wild bottlenose dolphins (*Tursiops aduncus*). *Marine Mammal Science*, *22*(4), 966–978.

Sánchez–Hernández, P., Krasheninnikova, A., Almunia, J., & Molina–Borja, M. (2019). Social interaction analysis in captive orcas (*Orcinus orca*). *Zoo Biology*, *38*(4), 323–333. https://doi.org/10.1002/zoo.21502

Schroeder, J., Dunning, J., Chan, A. H. H., Chik, H. Y. J., & Burke, T. (2024). Not so social in old age: Demography as one driver of decreasing sociality. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *379*(1916), 20220458.

Tamaki, N., Morisaka, T., & Taki, M. (2006). Does body contact contribute towards repairing relationships?: The association between flipper-rubbing and aggressive behavior in captive bottlenose dolphins. *Behavioural Processes*, *73*(2), 209–215. https://doi.org/10.1016/j.beproc.2006.05.010

Themelin, M., Dudzinski, K. M. (2024). Use of pair swimming positions in bottlenose dolphin male-male dyads based on age and kinship combination and social implications. Abstracts of the 52nd Annual Symposium of the European Association for Aquatic Mammals, Tenerife, Canary Islands, 13-15 March 2024.

Themelin, M., & Dudzinski, K. M. (2025). Bottlenose dolphins *(Tursiops truncatus)* pair swimming positions in non-mother-calf dyads. *Behaviour*, *162*(13-14), 991–1029. https://doi.org/10.1163/1568539X-bja10333

Themelin, M, Dudzinski, K. M., Manitzas Hill, H. M., Robeck, T. (2025). Social behaviors of killer whales and other delphinids. Abstracts of the 53rd Annual Symposium of the European Association for Aquatic Mammals, Beauval, France, 11-14 March 2025.

Themelin, M., Manitzas Hill, H. M., Robeck, T., Felice, M., & Dudzinski, K. M. (2026). Exploring association and social networks based on proximity and inter-individual interactions in a group of managed care killer whales. *Animal Behavior and Cognition, 13*(4), 385-406. https://doi.org/10.26451/abc.13.04.04.2026

Themelin, M., Ribic, C. A., Melillo-Sweeting, K., & Dudzinski, K. M. (2020). A new approach to the study of relationship quality in dolphins: Framework and preliminary results. *Behavioural Processes*, *181*, 104260. https://doi.org/10.1016/j.beproc.2020.104260

Tixier, P., Gasco, N., Towers, J. R., & Guinet, C. (2021). Killer whales of the Crozet Archipelago and adjacent waters: Photo-identification catalogue, population status and distribution in 2020. Centre d'Études Biologiques de Chizé, Centre National de La Recherche Scientifique, France.

Tosh, C. A., De Bruyn, P. J. N., & Bester, M. N. (2008). Preliminary analysis of the social structure of killer whales, *Orcinus orca*, at subantarctic Marion Island. *Marine Mammal Science*, *24*(4), 929–940. https://doi.org/10.1111/j.1748-7692.2008.00233.x

Úbeda, Y., Ortín, S., Robeck, T. R., Llorente, M., & Almunia, J. (2021). Personality of killer whales (*Orcinus orca*) is related to welfare and subjective well-being. *Applied Animal Behaviour Science*, *237*, 105297. https://doi.org/10.1016/j.applanim.2021.105297

Úbeda, Y., Ortín, S., St. Leger, J., Llorente, M., & Almunia, J. (2019). Personality in captive killer whales (*Orcinus orca*): A rating approach based on the five-factor model. *Journal of Comparative Psychology, 133*(2), 252–261. https://doi.org/10.1037/com0000146

Van Weelden, C., Tixier, P., Doniol-Valcroze, T., Guinet, C., & Towers, J. R. (2025). Divergent killer whale populations exhibit similar acquisition but different healing rates of conspecific scars. *Behavioral Ecology and Sociobiology*, *79*(3), 39. https://doi.org/10.1007/s00265-025-03576-6

Vergara, V., Michaud, R., & Barrett-Lennard, L. (2010). What can captive whales tell us about their wild counterparts? Identification, usage, and ontogeny of contact calls in belugas (*Delphinapterus leucas*). *International Journal of Comparative Psychology*, *23*(3). https://doi.org/10.46867/ijcp.2010.23.03.08

Visser, I. N. (1998). Prolific body scars and collapsing dorsal fins on killer whales (*Orcinus orca*) in New Zealand waters. *Aquatic Mammals*, *24*(2), 71–81.

Weiss, M. N., Franks, D. W., Giles, D. A., Youngstrom, S., Wasser, S. K., Balcomb, K. C., Ellifrit, D. K., Domenici, P., Cant, M. A., Ellis, S., Nielsen, M. L. K., Grimes, C., & Croft, D. P. (2021). Age and sex influence social interactions, but not associations, within a killer whale pod. *Proceedings of the Royal Society B: Biological Sciences*, *288*(1953), 20210617. https://doi.org/10.1098/rspb.2021.0617

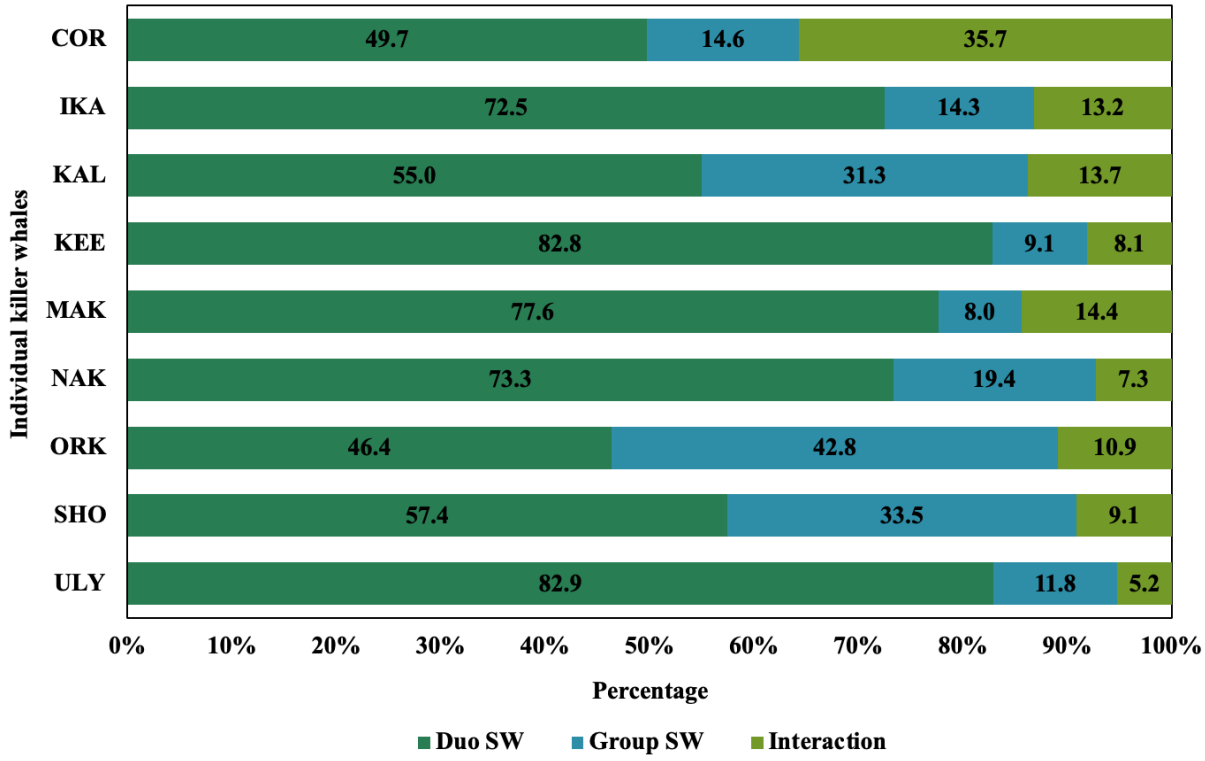
Wrzus, C., Hänel, M., Wagner, J., & Neyer, F. J. (2013). Social network changes and life events across the life span: A meta-analysis. *Psychological Bulletin*, *139*(1), 53–80. https://doi.org/10.1037/a0028601

Yamamoto, C., & Kashiwagi, N. (2023). Affiliative behavior after aggressions in common bottlenose dolphins (*Tursiops truncatus*). *Aquatic Mammals*, *49*(3), 288–293. https://doi.org/10.1578/AM.49.3.2023.288

Supplementary Materials

Figure S1

Distribution in Percentages of Each Social Subcategory per Individual Killer Whale



Note. See Table S1 for counts.

Table S1

Event Counts for Each Social Subcategory per Individual Killer Whale

Individual	Duo SW	Group SW	Interaction	Total
COR	92	27	66	185
IKA	187	37	34	258
KAL	116	66	29	211
KEE	236	26	23	285
MAK	465	48	86	599
NAK	121	32	12	165
ORK	64	59	15	138
SHO	120	70	19	209
ULY	175	25	11	211
Total	1576	390	295	2261

Note. Event counts per killer whale and not scan counts, i.e., several events can be recorded during 1 scan.

Table S2

Date, Scan Time, and Individuals Involved in the Described Behaviors

Behavior	Date & Scan Time	Individuals
a) Gentle push	12 Sep 22, 12:09	SHO to KEE
	26 Jan 23, 13:00	
b) Cross-swimming	13 Jun 22, 10:04	MAK & KEE
	15 Jun 22, 16:06	MAK & SHO
	6 Aug 22, 15:08	KEE & IKA
	4 Nov 22, 14:07	ULY & MAK
c) Bird sharing	13 Jun 22, 13:10	KAL, SHO, ORK
d) Infant position	27 Apr 22, 9:00	MAK P3 to ULY
	7 Aug 22, 9:00 & 10:00	
	27 Apr 22, 10:00	
	7 Aug 22, 9:00 & 10:00	ULY P3 to MAK
	14 Jun 22, 7:00	MAK P3 to KEE
	14 Jun 22, 7:00	KEE P3 to MAK
	15 Jun 22, 6:00	SHO P3 to COR
	14 Jun 22, 6:01	IKA P3 to SHO
	4 Nov 22, 18:09	KAL P3 to ULY
	26 Jan 23, 16:00 & 17:00	MAK P3 to COR
	27 Jan 23, 13:09	SHO P3 to KEE
e) Beak-to-genital	13 Sep 22, 6:08	MAK to ULY (e1)
	26 Jan 23, 13:09 & 13:10	SHO to KEE (e2)
f) Socio-sexual	27 April 22, 6:05	IKA mount NAK
	27 April 22, 9:04	MAK mount ULY
	7 Aug 22, 18:07	MAK penis out while swimming with ULY
g) Group swims	28 Apr 22, 9:00	KAL-SHO-MAK-ULY from left to right
	6 Aug 22, 6:00	SHO-KAL-ORK-MAK from left to right
	13 Sep 22, 18:00	KEE-SHO-ORK from left to right
	6 Nov 22, 11:00	KAL, KEE, MAK, ORK, and SHO

Note. Most of these behaviors were observed on several occasions. The dates and scan times reported here are examples and do not equate to frequency of observation for these behaviors. The letter designated in the behavior column (e.g., a., b., etc.) match to the text list of behavior examples. P3 is infant position.