Statement of Purpose - Vasudha Kulkarni

I became interested in animal behaviour when I audited an animal behaviour course as a first-year undergraduate. After my second year, guided by Prof Raghavendra Gadagkar at IISc Bangalore, I read several books on animal cognition, brood parasitism, and the evolution of female sexuality in primates while also doing a literature review on principles of social immunity. This review on how insect societies deal with infectious diseases shifted my curiosity towards group-level behaviour in eusocial insects. I wanted to study how local interactions between individuals can give rise to such astounding complexity in the regulation and functioning of the colony as a whole.

Prof. Sylvia Cremer has done pioneering work on group-level anti-parasitic behaviour in eusocial insects, known as social immunity. I joined her lab at ISTA the summer after my third year to study social immunity in ants. I worked with Linda Sartoris, a PhD student, who was studying the effect of pathogen experience on hygienic behaviour. Her study showed that an ant with a recent pathogen experience reduced its larval grooming. To understand this unexpected result, I conducted a survival experiment, revealing that low concentrations of fungal spores were fatal to larvae but not worker ants due to their self-grooming ability. Thus, ***the pathogen-experienced ant reduced larval grooming to minimise the risk of low-level contamination***. Expanding on this work, I tested if recent pathogen experience affects *induced* larval grooming by exposing pathogen-experienced ants to contaminated larvae but did not find a significant effect. This experience fueled my passion for experimental work, enhancing my skills in designing, conducting and analysing controlled experiments. I also acquired lab skills and techniques like maintaining ant colonies, fungal spore extraction, DNA extraction and quantitative PCR.

During my fourth year at IISER Pune, I worked with Dr. Raghav Rajan, exploring the mechanisms underlying song initiation in zebra finches. Zebra finches begin their songs with short, repeated syllables called introductory notes (INs), which are hypothesised to play a preparatory role for song-related motor activity. The mean number of INs produced by adult finches is stereotyped and learnt as a juvenile from adult tutors. I developed a closed-loop negative-reinforcement-based behavioural assay to test if adult zebra finches can learn to reduce the number of INs. I modified a Python-based audio recording program to ***detect INs in real time and punish the bird with white noise for singing multiple INs***. I managed to significantly reduce the mean number of INs in a test bird. Further studies will show whether this reduction in INs has a negative effect on song structure and initiation. With this project, I enjoyed working with quantitative behavioural data and learning new software and programming to solve specific tasks in gathering and analysing this data.

I wanted to use my experience with quantitative behaviour and computational methods in studying complex social interactions in primates. I approached Prof. Judith Burkart at the University of Zurich to study cooperation in common marmosets and secured funding by applying to the A.H. Schultz Foundation for a grant. Like humans, marmosets exhibit proactive prosociality, group-level coordination and joint action via turn-taking and perspective-taking. Bio-behavioural synchrony is hypothesised to be the proximate mechanism of cooperation in humans. Through my project, I aim to study ***behavioural synchrony and pose imitation in marmoset dyads before and after they perform a cooperative task***. I'm using DeepLabCut to extract 3D trajectories of interacting marmosets and quantify posture synchrony using recurrence analysis to understand the

effect of cooperation on behavioural synchrony. I'm also investigating how marmosets use mutual gazing to coordinate during the task. Studying the process of synchronisation in marmosets will help us understand the overlap of proximate mechanisms regulating cooperation and social cognition in humans and marmosets.

Through this research experience, I have expanded my skill set, working with marmosets, fabricating experimental tasks and building an analysis pipeline. I have experience working with and handling diverse animal models across behavioural paradigms and have developed the ability to learn new tools and software swiftly. In addition to my research experience, I have fortified my theoretical background through advanced elective courses in ecology, evolution, animal behaviour, and neuroscience, as well as statistical learning, generalised linear models and bioinformatics.

I'm committed to pursuing an academic career studying social behaviour in animal societies, and I believe that the PhD program at ISTA offers the best opportunities to develop the necessary skills for a future researcher in this field. I want to understand various facets of group dynamics, including the evolution of sociality, cooperation and conflict within groups, factors shaping social structure organisation and the role of communication in maintaining sociality. In my prospective PhD research, I would like to work with Prof. Sylvia Cremer to study colony-level responses to pathogens. I aim to study social behaviour in insect colonies using controlled experiments to answer specific questions and mathematical modelling approaches to identify patterns in complex behaviour, build theories, and make further predictions. Combining my previous experience working with ants and automated behavioural analysis, I would like to use automated individual tracking and behavioural classification algorithms to construct multi-layered social networks from grooming, proximity and trophallaxis interactions to understand how the colony social structure changes in response to different kinds of pathogen exposure. Studying the response in network topology might help us understand how ant colonies shift strategies at different group sizes.

I have cutting-edge research experience with diverse animal models and proficiency with various experimental and analytical tools. I want to build upon my competencies and use multidisciplinary approaches to understand the principles underlying behavioural phenomena. If accepted into the program, I'd like to rotate with Dr. Maximilian Jösch to study neural processing of visual information using optogenetics to investigate neural circuits and modelling methods to understand neuronal computation. This rotation would help me gain better insights into the broader field of behavioural neuroscience.

For a rotation outside my area of expertise, I'd like to work with Prof. Gasper Tkačik, whose work on modelling and analysing complex systems is fascinating. In working with Prof. Tkačik, I want to learn various modelling and analysis techniques used to understand dynamic biological systems across levels of organisation, from efficient information encoding in neural networks to the evolutionary accumulation of information at the population level. This rotation would help me build a theoretical foundation that I can use to build models of local interaction rules that give rise to collective behaviour. The intellectually vibrant and multidisciplinary environment at the Institute of Science and Technology Austria promises not only to enrich my academic journey but also to foster interdisciplinary collaborations that will enhance the depth and breadth of my research pursuits.