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An independent academic psychologist, based in England, who has written extensively on different areas of psychology with an emphasis on the critical stance towards traditional ideas.

A complete listing of his writings at http://psychologywritings.synthasite.com/. See also material at https://archive.org/details/orsett-psych.

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1. EVOLUTION OF WOMEN'S CO-OPERATION

1.1. INTRODUCTION

"Co-operation is a central and universal element in human societies and foundational to derived human traits, such as food sharing, pooled energy budgets and the division of labour" (Fox et al 2023a p1). The co-operation between women and girls over evolutionary history has been less studied compared to men's co-operation (Fox et al 2023a).

Introducing a special issue of the "Philosophical Transactions of the Royal Society B", Fox et al (2023a) outlined five key themes:

i) No compelling evidence for universal gender differences in co-operation.

ii) Women's co-operation extends beyond kin.

iii) Differences in women's co-operation is a reflection of need, risk, and cultural norms.

iv) Co-operation and competition are intimately interconnected.

v) Women's co-operation is not just around childcare.

1.2. UNIVERSAL GENDER DIFFERENCES

Universal gender differences in social ties could be summarised as women prioritising ties conducive to childcare, while "males are expected to prioritise establishing social ties conducive to achieving status and easing male–male collective action (ie: group co-operation such as hunting and war) —particularly in the

wake of conflict" (Simpson and Power 2023 p1).

Simpson and Power's (2023) study of two Tamil villages in India over five years (2013-2017) found that men and women were "similarly social but channel their sociality differently" (p1). Gender-related differences in help-seeking were "modest". There was no support for the universal gender differences position.

House et al (2023) found no universal gender differences in co-operation in their analysis of two datasets.

One dataset (from two studies - House et al 2020, and House et al 2013) involved 663 children aged 4-14 years from fourteen different societies (urban and rural, industrialised and non-industrialised) playing the binary choice "Dictator Game" (DG). In the DG there are two players, and Player 1 is allocated a sum of money which they can share with Player 2 as much as they want. The amount given to Player 2 is used as a measure of pro-social behaviour.

House et al (2013) studied 3-14 year-olds at six different sites (eg: Fiji; Los Angeles, USA; Martu (Western Desert, Australia)), and House et al (2020) 4-17 year-olds at eight sites (eg: Phoenix, USA; Berlin, Germany; Shuar (Amazonia, Ecuador). The sharing of any money by Player 1 was classed as pro-social behaviour. Overall, males chose this option 34% of the time on average and females 27% of the time. For 7-10 years-old, males were more pro-social, but the data were not viewed as reliable by the researchers, rather a product of age. "There is also very little evidence for societal variation in gender differences in the DG" (House et al 2023 p7).

The second dataset (Blake et al 2015) included 430 children aged 4-15 years from seven different countries (eg: Boston, USA; Andhra Pradesh, India) playing the "Advantageous Inequity Game" (AIG) and the "Disadvantageous Inequity Game" (DIG). These measured fairness and were variations on the "Ultimatum Game" (UG). As in the DG, Player 1 can allocate money to Player 2, but now Player 2 decides to accept or not. If Player 2 accepts the offer, the money is allocated, but if they reject the offer, both players get nothing. In AIG scenarios, Player 1 offers Player 2 less than half the money, while in DIG scenarios, Player is offered more than half. In the former, the situation is unfair for Player 2, but unfair for Player 1 in the latter case. Overall, there were no gender differences in responses to fairness and unfairness.

The researchers concluded that the data were "consistent with the idea that gender has little impact on the development of pro-social behaviour and fairness during early childhood and early adolescence" (House et al 2023 p11). Accepting that the experimenters tested very specific behaviours, which the researchers acknowledged.

Among two Mosuo communities in southwest China, Mattison et al (2023) found "a mixture of 'feminine' and 'masculine' features" (p1) in social networks. The type of co-operative activity was important. Two activities were the focus of the study - co-operative meal preparation for festivals, funerals, and other community events (primarily done by women), and farm equipment lending (mainly by men). The communities varied in being matrilineal (inheritance via women's children) or patrilineal (inheritance from father to son). The community differences as well as the type of co-operative activity were as important as gender in understanding differences in behaviour.

Mattison et al (2023) concluded: "In general, as per our previous results [Mattison et al 2021], we find little evidence of universality of structures associated with gender, per se. Rather, there are both 'female' and 'male' characteristics among all network structures analysed here. At the same time, we could not fully separate gendered expectations in a given activity from the substance of the activity" (p9).

In a meta-analysis of studies using social dilemma games published between 1961 and 2017, Spadaro et al (2023) found "little-to-no evidence for an association between gender and co-operation..." (p1). Social dilemmas, like the "Prisoner's Dilemma" (PD), involve pay-offs for co-operation and non-co-operation. The basic scenario is two prisoners kept separately and the players must decide to keep quiet to the authorities (co-operation) or "shop" their partner (non-co-operation/ defection). The "K index" (Rapoport and Chammah 1965) has been used to score PD: Formally, $K = (R - P)/(T - S)$, where R denotes the pay-off for joint co-operation (reward),P for joint defection (punishment), T for unilateral defection (temptation), and S for unilateral co-operation (sucker)" (Spadaro et al 2023 p2).

One hundred and twenty-one studies (with 126 effect sizes) from twenty industrial societies were included in the meta-analysis. The criteria for inclusion included PD with strangers, and separate analysis of data from men

and women.

Studies that found more co-operation generally tended to have a higher number of female participants. But Spadaro et al (2023) warned caution here, particularly because of "potential methodological confounds related to changes in samples over time" (p5).

Table 1.1 lists the key methodological issues with the studies in the meta-analysis.

- The social dilemma game used (eg: over 90 studies used PD).
- The number of trials played by each participant.
- Gender composition of sample (eg: 50 studies had one gender only), and more recent studies were more likely to include women in the sample.
- Size of the pay-offs for co-operation and non-co-operation.
- Variables - eg: communication between partners or not; use of punishment for non-co-operation.
- Society in which study performed (mostly Western countries).
- Sample generally - eg: students.

Table 1.1 - Key methodological issues in studies in Spadaro et al's (2023) meta-analysis.

1.3. CO-OPERATION BEYOND KIN

Hruschka et al (2023) began: "A theoretical keystone of the evolutionary social sciences has been the importance of genetic relatedness in promoting co-operation and helping among individuals. Decades of empirical studies have also demonstrated that close genetic relatives are more likely to co-operate on collective tasks, to help each other in times of need and to share with each other. More recently, evolutionary social scientists have recognised the importance of other social relationships that do not rely on direct genetic relatedness to promote co-operation. These include (i) reciprocity, (ii) the cultivation of long-term ties based on mutual aid, (iii) mobilisation of groups toward mutually beneficial tasks and (iv) unrelated affinal kin sharing genetic interests in offspring" (p1).

1.3.1. Humans

In patrilocal societies the wife moves to the home of the husband at marriage. This means that the wife can lack social support compared to women who remain in their natal village at marriage.

Hruschka et al (2023) investigated this situation in ten villages in rural Bangladesh. The study included women who had moved included at marriage, and those who had stayed in their childhood village. Social support was defined as individuals in the village the interviewee would "(i) trust for advice in several domains (ie: health, getting loans and saving money), (ii) seek support from during a dispute within either their household or their village and (iii) ask for monetary loans of varying amounts... to cover a variety of needs and emergencies (eg: pay back a micro-loan, buy food for their family and pay for a health emergency)" (Hruschka et al 2023 p3).

It was found that "women who migrated to their husband's village for marriage started with almost no adult close kin (mean 0.07) compared to women who remained in their childhood village (mean 2.38). However, immigrants eventually compensated for the lack of genetic kin by a combination of close affinal kin [eg: in-laws] and close friends. Indeed, immigrants reported more close non-kin friends than did non-immigrants (mean 1.27 versus 0.95). Moreover, immigrant women reported as many supportive ties in a range of domains and received as many nominations as support partners from other villagers" (Hruschka et al 2023 p4). So, women new to a village worked to form social networks, including non-kin.

Seabright et al (2023), based on their research in nine communities in Bolivia between 2002 and 2007, felt that "patrilocality per se is not costly to Tsimane women" (p1). These researchers studied the social support of 181 Tsimane women living in four different situations - with their in-laws (patrilocal), with their parents (matrilocal), both (bilocal - ie: both families lived in same village), or neither (neolocal - ie: married couple lived away from both sets of parents). Proximity to kin was key for the women receiving social support, irrelevant of the form of social structure. "Relative to women living closer to their in-laws, women living closer to their parents are less likely to be alone or solely in the company of their nuclear family..., and more likely to be observed with others when engaging in food

processing and manufacturing of market or household goods, but not other activities. Women are slightly more likely to receive childcare support from outside the nuclear family when they live closer to their parents... Their social group size and their children's probability of receiving allocare decrease significantly with distance from their parents, but not their in-laws" (Seabright et al 2023 p1).

The data were observations at thirty-minute intervals over 33 hours in total of the location, activity, and proximity to others of a focal individual. The observations included during hunting, fishing, and gathering of food, food preparation, manufacturing, and field labour.

1.3.2. Non-Humans

"Co-operation requires that partners reconcile their competing interests to each gain a direct net benefit from the co-operative behaviour, making partner choice a critical challenge. Aggressive coalitions are a widespread example of co-operation in animal societies" (Fox et al 2023b p1). Kin is an obvious factor in partner choice, but also familiarity, tolerance, and reliability with non-kin (Fox et al 2023b).

Fox et al (2023b) bond strength and co-operation among female chimpanzees in Kibale National Park in Uganda. Ten years of observational data (2010-2019) on twenty-six females were analysed. Affiliation (or bond strength or relationship quality) was scored by physical closeness (ie: "five-metre association"), grooming duration, and "party association" (ie: how often seen in the same party) for each dyad.

Overall, 22 of the females were involved in at least one coalition (eg: joining together to attack another individual). The three measures of relationship quality positively predicted coalitions, but the strength of bond (based on grooming duration) was not a pre-requisite of co-operation. Social tolerance was key in non-kin coalitions (based on physical closeness).

The researchers concluded: "Our findings indicate that social tolerance facilitates co-operation in coalition formation for female chimpanzees, while kinship and strong social bonds do not bolster co-operation as it does in other female philopatric primates. This highlights a case where even relatively weak social ties, maintained largely through spatial association and occasional grooming, can support co-operation" (Fox et al

2023b p8).

They continued later: "Female chimpanzees present a striking paradox where the threshold for co-operating in coalitions appears to be quite low, yet females rarely engage in them and do not appear to invest in stronger bonds to enhance the potential for co-operation" (Fox et al 2023b p10). This is quite different to bonobos.

Young and Robbins (2023) studied female-female associations in wild mountain and western gorillas in Uganda (observed from 2001 to 2019) and Gabon (studied 2015 to 2019). Spatial proximity was used as the measure of association (ie: within five metres of each other) when observers scanned every ten minutes during four-hour observation periods. These data were converted into a dyad "association score".

There was evidence of female-female association (ie: a preference to be near a particular individual) that was consistent over time and individual. "If an individual's dyad partner was their top association partner in one year, it was most likely they were also their top association partner in the previous year" (Young and Robbins 2023 p5).

Mountain gorillas had a higher mean association score than western gorillas, but this was not statistically significant. Note that the "... western gorillas' food resources are more dispersed, this may lead to each female spending on average less time in spatial proximity to the alpha male and each other" (Young and Robbins 2023 pp6-7).

The associations appeared flexible and variable, and this may be due to the nature of the female experience. "Females of both species disperse from their natal group and may transfer between social groups multiple times in their lives, such that residing with close kin (mothers, daughters or siblings) is not common. Emigration rates are higher for western gorilla females than for mountain gorillas, which may be due to female mountain gorillas having more within-group mate choice because they often reside in multi-male groups or due to female western gorillas responding to feeding competition by emigrating to smaller groups. Females are believed to associate with a silverback (adult male) for protection against infanticide from other males and predation" (Young and Robbins 2023 p2).

Studies like this may give clues to the evolution of human behaviours.

More generally, Smith et al (2023) examined intra-

group coalitions in group-living mammals. They performed a literature search using "Google Scholar", and found information on 58 species. The probability of coalitions by females only, males only, or by both sexes were calculated for each species. No difference was found overall - ie: "conditional on having any coalitions at all, the typical extant mammal is just as likely to have female-only, male-only or both-sex coalitions" (Smith et al 2023 p4). Thus, no sex differences in this form of co-operation.

But Smith et al (2023) acknowledged that "information about intra-group coalition formation is not available for many mammalian species that form social groups and could potentially form intra-group coalitions. Although coalitions are relatively conspicuous events, they are uncommon and difficult to study systematically. This means that they may occur in some species even though they have not been described in the literature" (p8).

1.4. DIFFERENCES IN WOMEN'S CO-OPERATION

Kramer (2023) asserted: "The assumed primacy of male bonding, hunting, patrilocality and philopatry has dominated the discussion of co-operation without balanced consideration. A closer look at the ethnographic record reveals that in addition to co-operative childcare and food production, women and girls collectively form coalitions, have their own co-operative political, ceremonial, economic and social institutions, and develop female-based exchange and support networks. The numerous ethnographic examples of female co-operation urge reconsideration of gender stereotypes and the limits of female co-operation" (p1). The theoretical tradition taken (eg: evolutionary biology; anthropology) influences the views on females as co-operators and competitors.

Kramer (2023) outlined three opportunities for women to co-operative and compete:

i) Living in multi-level groups (eg: biological family; extended family; tribe) - eg: co-operation varies depending on the partner.

ii) Across the lifespan - "The combination of early weaning, short birth intervals and caring for juveniles as well as infants together commit mothers to raise overlapping dependents. This unusual life history, which took shape over millions of years, at some point in the

past would have posed a problem for mothers: how to find the time to provide both primary care to young children and the food and other resources to older children. Co-operative assistance from her own children, her mother, and other helpers to solve this time allocation problem is a trait that distinguishes humans among primates" (Kramer 2023 p4).

iii) Reproductive conflict - Mothers may compete for access to childcare help from the same pool of helpers. For example, among Gambian women in West Africa where the mothers' childbearing years overlap with those of their daughters have "shorter reproductive careers and lower completed fertility" (Kramer 2023 p5).

Yet in the same society, "the presence of her mother and sisters is associated with improved survival and the nutritional status of her children. In other Gambian studies, women who live with a mother-in-law have higher chances of giving birth" (Kramer 2023 p5).

Bedrov and Gable (2023) commented: "The relationship between social support and well-being is well established in social psychology, with evidence suggesting that these benefits are especially prominent among women. When faced with an environmental stressor, women are more likely to adopt a tend-and-befriend strategy rather than fight-or-flight. Furthermore, female friendships tend to be higher in self-disclosure and more frequently relied on for social support, which is associated with physical and psychological benefits. Women are also more effective at providing social support, further augmenting those benefits" (p1).

Despite this general statement, these authors warned caution about "generalising the benefits of women's social ties to all women" (Bedrov and Gable 2023 p5). Put another way, are there cultural differences in these behaviours?

One way to distinguish cultures is in terms of individualism-collectivism, ie: "the extent to which individuals perceive themselves as independent and unique or interdependent and connected to others" (Bedrov and Gable 2023 p5).

Bedrov and Gable (2023) gave this illustration: "A key value of collectivist societies is preserving harmony and putting others' needs above the self, which can manifest in a hesitancy to seek out social support and not wanting to harm or burden close others with one's problems. Indeed, Asians and Asian Americans are less likely to seek out social support in response to

stressors compared to European Americans, with relational and group harmony concerns being the primary reasons for this reluctance" (p5). How social support fits cultural expectations can be seen in its benefits (or not) in laboratory-induced stressful situations (eg: Taylor et al 2007).

The nature of women's social ties may also vary based on the individualism-collectivism dimension (eg: higher emotional reliance on friends in the USA compared to South Korea; Ryan et al 2005) (Bedrov and Gable 2023).

Pragmatically, Bedrov and Gable (2023) admitted that "the individualist–collectivist distinction is but one of many socio-cultural dimensions that may explain cross-culture differences in social support" (p6).

Co-operation in food acquisition was described by Kraft et al (2023) as "a hallmark of the human species" (p1). These researchers found differences in relation to this behaviour between hunter-gatherer and horticulturalist societies based on risk of food acquisition. "Hunter–gatherers often forage in groups and are generally more interdependent and experience higher short-term food acquisition risk than horticulturalists, suggesting that co-operative labour should be more widespread and frequent for hunter–gatherers" (Kraft et al 2023 p1) [1].

The researchers compared female co-operative labour networks of the Batek in Malaysia (hunter-gatherers) and the Tsimane in Bolivia (fishing-horticulturalists). The former co-operate in diffuse networks of kin and non-kin, while the latter were "confined mostly to spouses and primary and distant kin" (Kraft et al 2023 p1).

These findings fit with the view that how a species acquires food determines social organisation and structure. "The evolution of group size, the most fundamental component of animal social systems, is thought to be driven primarily by two factors: predation risk and resource competition/availability. For example, many ungulate herbivores rely on abundant, evenly distributed resources and live in large herds that increase protection against predators, whereas the majority of carnivores are solitary and have few social interactions outside of mating" (Kraft et al 2023 pp1-2). Applying this to humans, the type of society based on food acquisition influences social interactions. "Humans

[1] The "interdependence hypothesis" (eg: Tomasello 2016) asserts that "an ecological shift to foods that were not individually obtainable drove increased interdependence and selection for less selfish, more co-operative foraging partners" (Kraft et al 2023 p9).

living in subsistence societies devote large amounts of time to food procurement, and these activities are often done in social groups, even when they do not require co-operation to be successful. Social foraging thus provides critical opportunities for the exchange of information, gossip, pro-social signalling, trust-building and friendship formation" (Kraft et al 2023 p2).

The data used by Kraft et al (2023) on the Batek were collected in the 1970s in Peninsular Malaysia (eg: Endicott and Endicott 2008), and the Tsimane in interviews with over 1100 individuals between 2005 and 2019 in the lowland Amazonia region of Bolivia.

Among the Agta of the Philippines, there are mobile hunter-gathers and settled communities. Studying childcare co-operation for 78 children, Page et al (2023) found that grandmothers and sisters played a more important role in settled camps, and male kin less of a role compared to mobile communities. This showed that "women's social networks are flexible and respond to changes in subsistence and the environment" (Page et al 2023 p1).

Page et al (2023) examined their data in relation to risk-buffering strategies. "Risk is the probability of loss, losses that negatively impact fitness as they restrict organisms' ability to survive and reproduce. Consequently, adaptations are expected to evolve to limit these losses" (Page et al 2023 p2). One strategy is "risk-pooling", where households co-operate to share the risk. "Mothers with infants may reduce their investment in food production because of the constraints of breastfeeding and intensive needs of the infant, a pressure that reduces as children age. A mother's reduction in food production results in shortfalls at the household level, which can be addressed by increased production of males, food sharing with other households or by providing mothers with more childcare support" (Page et al 2023 p2).

An alternative strategy is "risk-retention", where a household increases its resources in good times in order to absorb any losses in the future. "Individuals with more resources have less need for larger networks, withdrawing from them as the direct benefits from reciprocal co-operation are reduced. Instead, more childcare may originate from household members (father and siblings) and grandparents, who receive indirect benefits of co-operation via inclusive fitness" (Page et al 2023 pp2-3).

Page et al (2023) collected their data in 2013 and

2014 by observing over 900 individuals in total. Seventy-eight children (0-6 years old) were "focal followed" during 10-14 days. During observations, the activity of the focal child was recorded every 20 seconds, and who came within three metres in terms of childcare (which was categorised as low- and high-investment forms). "Low-investment activities include touching, proximity watching, supervising, being in a playgroup with a child or talking to a child (also referred to in the literature as indirect childcare). High-investment activities included feeding, cleaning, holding or carrying, playing or otherwise actively engaging with the focal child" (Page et al 2023 p3).

1.5. CO-OPERATION AND COMPETITION ARE CONNECTED

Because co-operation and competition are connected, it is possible that women have evolved the strategy to suppress competitive behaviours in order to maintain co-operation [2]. Cassar and Rigdon (2023) argued that this suppression of competition is "to elicit co-operation for the benefit of raising offspring" (p1).

The focus of these researchers is "winner-takes-all" (WTA) situations, which is also the case in experimental games. For example, Gneezy et al (2003) used the competition of solving computational mazes, and found that men outperformed women in a WTA condition. But there was no difference in a non-competitive version (where participants were paid individually for correct answer - a "piece-rate" condition). When given the choice of the type of situation, in another study (Niederle and Vesterlund 2007), twice as many men preferred the WTA option than women. These general patterns vary depending on certain variables (eg: the type of incentive; culture; nature of the task) (Cassar and Rigdon 2023).

Cassar and Rigdon (2023) used experimental games to provide evidence to support their hypothesis of female suppression of competition by framing the contest "as something beneficial to the offspring or gender-typical" (p6). For example, Cassar et al (2016) recruited over 350 parents of school-age children in China for a mathematics competition. The prize in the WTA competition was either

[2] Muller and Mitani (2005) noted: "If co-operation can be analysed via natural selection operating on individuals, a new way to conceptualise the process emerges. Instead of viewing co-operation as distinct from competition, it becomes productive to regard them together. Students of animal behaviour have long recognised that an artificial dichotomy may exist insofar as animals frequently co-operate to compete with conspecifics. In taxa as diverse as insects, birds, and mammals, animals co-operate to obtain immediate or deferred fitness benefits" (quoted in Smith et al 2023).

money or bookshop vouchers for their child. In the former condition men outperformed women, but not when the prize was the vouchers.

Another variation on the WTA situation where women perform as well as men is when the winner can share their winnings with the loser ("pro-social option"). This was shown in a study by Cassar and Rigdon (2021) with participants recruited from "Amazon Mechanical Turk". But the female winners only shared slightly more than the male ones. Cassar and Rigdon (2023) explained: "It appears that just the presence of the pro-social option was sufficient to shield the women from appearing competitive to others and, more likely, to themselves" (p7).

The researchers summed up their findings over a number of experiments: "Displaying a pro-social nature, avoiding overt conflicts and preferring the possibility of a more egalitarian distribution of gains and rewards that could benefit others allow women to compete and co-operate simultaneously... Grounding our argument in a vast body of work in economics, evolutionary psychology and anthropology, we propose that women are not less competitive than men but express it differently, through strategies more attuned to the needs to nourish supportive relationships with others (fathers and other allomaternal helpers) in order to raise energetically expensive offspring" (Cassar and Rigdon 2023 p8).

"In real-world scenarios, women's inclination to co-operate or compete can directly influence their reproductive fitness. In human societies, women depend on others for help in co-operatively raising offspring, and if multiple women rely on the same pool of helpers, it raises the potential for competition over access to help" (Fox et al 2023a p4).

The competition for helpers and resources can occur between related women (eg: in-laws; co-wives; mother-daughter) or unrelated ones. The exact nature of the competition depends upon the socio-ecological contexts (eg: polygynous households; women dispersing to husband's household). For example, some studies have found that more co-wives increases child mortality, and reduces the choice of giving birth for young women (eg: Gambia (Mace and Alvergne 2012); Dogon of Mali (Strassmann 1997) (Hackman and Kramer 2023).

Hackman and Kramer's (2023) analysis of 25 years of data (1982-2007) on the Savanna Pume, hunter-gatherers in Venezuela, however, did not support these studies. The detailed reproductive histories of 44 women were

available. It was found that the odds of giving birth increased with the presence of closely related women, and child mortality was unrelated to the number of co-resident women. Reproductive success showed no significant relationship to female kin networks. Environmental factors, like food availability, appeared important in reproductive decisions.

Hackman and Kramer (2023) argued that the competition for helpers and resources is attenuated when there is a large pool of helpers in a hunter-gatherer society. Also foraging populations are more flexible than agricultural and pastoralist ones. "Indeed, most of the evidence for reproductive conflict in small-scale groups comes from non-foraging populations. Female reproductive competition is also more salient in contexts with labour constraints, where women's food acquisition or production trades off with childcare. Indeed, these contexts show not only increased reproductive competition among unrelated women, but competition among siblings as well" (Hackman and Kramer 2023 p11).

Foraging populations may not be completely egalitarian, but "the rates of inequality are among the lowest among human social systems. Indeed, ethnographic accounts of hunter–gatherers are rife with descriptions of social and behavioural mechanisms that reduce conflict and accumulation of resources and wealth. It is reasonable to expect that these mechanisms also extend to biological currencies of reproductive success" (Hackman and Kramer 2023 p11).

1.6. CO-OPERATION BEYOND CHILDCARE

Starkweather et al (2023) outlined their research interest: "Across human societies, women's economic production and their contributions to childcare are critical in supporting reproductive fitness for themselves, their spouses and children. Yet, the necessity of performing both work and childcare tasks presents women with an adaptive problem in which they must determine how best to allocate their time and energy between these tasks. Women often use co-operative relationships with alloparents to solve this problem, but whether or not women co-operate across different domains (eg: work and childcare) to access alloparents remains relatively under-explored" (p1). These researchers sought data on the subject from Shodagor households in Bangladesh.

The Shodagor are fisher-traders, and approximately

500 families in Matlab district were interviewed in 2014. Women work primarily as fishers or traders. In terms of childcare, it is possible to fish and care for children, but not trade and care for them. So, the researchers focused on co-operation in childcare.

The co-operative networks of the women varied between traders and fishers. Specifically, traders co-operate together in childcare and trading, while fishers tend to name relatives as alloparents. Traders had larger networks than fishers. Traders were "drawing from different pools of potential alloparents — which include their spouses, kin with whom they do not work, and both kin and non-kin work partners — to ensure their households' childcare needs are met while they are working" (Starkweather et al 2023 p9).

1.7. REFERENCES

Bedrov, A & Gable, S.L (2023) Thriving together: The benefits of women's social ties for physical, psychological and relationship health Philosophical Transactions of the Royal Society B 378, 20210441

Blake, P.R et al (2015) The ontogeny of fairness in seven societies Nature 528, 258-261

Cassar, A & Rigdon, M.L (2021) Option to co-operate increases women's competitiveness and closes the gender gap Evolution and Human Behaviour 42, 556-572

Cassar, A & Rigdon, M.L (2023) Sustaining the potential for co-operation as female competitive strategy Philosophical Transactions of the Royal Society B 378, 20210440

Cassar, A et al (2016) Competing for the benefit of offspring eliminates the gender gap in competitiveness Proceedings of the National Academy of Sciences, USA 113, 5201-5205

Endicott, K.M & Endicott, K.L (2008) The Headman was a Woman: The Gender Egalitarian Batek of Malaysia Long Grove, IL: Waveland Press

Fox, S.A et al (2023a) New perspectives on the evolution of women's co-operation Philosophical Transactions of the Royal Society B 378, 20210424

Fox, S.A et al (2023b) Weak, but not strong, ties support coalition formation among wild female chimpanzees Philosophical Transactions of the Royal Society B 378, 20210427

Gneezy, U et al (2003) Performance in competitive environments: Gender differences Quarterly Journal of Economics 118, 3, 1049-1074

Hackman, J & Kramer, K.L (2023) Kin networks and opportunities

for reproductive co-operation and conflict among hunter-gatherers Philosophical Transactions of the Royal Society B 378, 20210434

House, B.R et al (2013) Ontogeny of pro-social behaviour across diverse societies Proceedings of the National Academy of Sciences, USA 110, 14586-14591

House, B.R et al (2020) Universal norm psychology leads to societal diversity in pro-social behaviour and development Nature Human Behaviour 4, 36-44

House, B.R et al (2023) No strong evidence for universal gender differences in the development of co-operative behaviour across societies Philosophical Transactions of the Royal Society B 378, 20210439

Hruschka, D.J et al (2023) Starting from scratch in a patrilocal society: How women build networks after marriage in rural Bangladesh Philosophical Transactions of the Royal Society B 378, 20210432

Kraft, T.S et al (2023) Female co-operative labour networks in hunter-gatherers and horticulturalists Philosophical Transactions of the Royal Society B 378, 20210431

Kramer, K.L (2023) Female co-operation: Evolutionary, cross-cultural and ethnographic evidence Philosophical Transactions of the Royal Society B 378, 20210425

Mace, R & Alvergne, A (2012) Female reproductive competition within families in rural Gambia Proceedings of the Royal Society B 279, 2219-2227

Mattison, S.M et al (2021) Gender differences in social networks based on prevailing kinship norms in the Musuo of China Social Sciences 10, 7, article 253

Mattison, S.M et al (2023) Does gender structure social networks across domains of co-operation? An exploration of gendered networks among matrilineal and patrilineal Mosuo Philosophical Transactions of the Royal Society B 378, 20210436

Muller, M.N & Mitani, J.C (2005) Conflict and co-operation in wild chimpanzees Advances in the Study of Behaviour 35, 275-331

Niederle, M & Vesterlund, L (2007) Do women shy away from competition? Do men compete too much? Quarterly Journal of Economics 122, 1067-1101

Page, A.E et al (2023) Sedentarisation and maternal childcare networks: Role of risk, gender and demography Philosophical Transactions of the Royal Society B 378, 20210435

Rapoport, A & Chammah, A (1965) Prisoner's Dilemma: A Study in Conflict and Co-operation Ann Arbor, IL: University of Michigan Press

Ryan, R.M et al (2005) On the interpersonal regulation of emotions: Emotional resilience across gender, relationships, and

cultures Personal Relationships 12, 145-163

Seabright, E et al (2023) Repercussions of patrilocal residence on mothers' social support networks among Tsimane forager-farmers Philosophical Transactions of the Royal Society B 378, 20210442

Simpson, C.R & Power, E.A (2023) Dynamics of co-operative networks associated with gender among South Indian Tamils Philosophical Transactions of the Royal Society B 378, 20210437

Smith, J.E et al (2023) Sex differences in co-operative coalitions: A mammalian perspective Philosophical Transactions of the Royal Society B 378, 20210426

Spadaro, G et al (2023) Gender differences in co-operation across 20 societies: A meta-analysis Philosophical Transactions of the Royal Society B 378, 20210438

Starkweather, K.E et al (2023) Shodagor women co-operative across domains of work and childcare to solve an adaptive problem Philosophical Transactions of the Royal Society B 378, 20210433

Strassmann, B.I (1997) Polygyny as a risk factor for child mortality among the Dogon of Mali Current Anthropology 38, 688-695

Taylor, S.E et al (2007) Cultural differences in the impact of social support on psychological and biological stress responses Psychological Science 18, 831-837

Tomasello, M (2016) A Natural History of Human Morality Cambridge, MA: Harvard University Press

Young, C & Robbins, M (2023) Association patterns of female gorillas Philosophical Transactions of the Royal Society B 378, 20210429

2. WOMEN, MEDIA, AND MENTAL HEALTH

Thelandersson (2023) characterises the 21st century as having a "shift in Western media culture from a primarily positive and upbeat affective register to one that has space for some talk of negative and downtrodden feelings" (p2). With particular reference to women's experiences, she situated "the increased visibility of mental illness against a backdrop of a neoliberal and post-feminist culture that privileges individualism and personal choice, placing the responsibility for happiness and well-being solely on the individual" (Thelandersson 2023 p2).

Furthermore, this context presents "women as ideal neoliberal subjects. Women in particular are hailed as subjects of capacity that have the potential for great success if they just work hard enough on themselves. Depression, however, is associated with debility and the incapacity to act" (Thelandersson 2023 p2).

In terms of media culture, the emphasis is upon positive feelings like confidence, empowerment, and resilience, and "'can-do' girls" (Dobson and Kanai 2019). Orgad and Gill (2022) noted "how the imperative to confidence for women within twenty-first-century media culture often works to dismantle feminist messages of their structural critique and place the solution to social injustice on the individual. By working on their confidence and self-esteem, women are presumed to overcome systemic issues" (Thelandersson 2023 p3).

But "the vulnerability turn" (Orgad and Gill 2022), where women express weakness, insecurities and self-doubt, does not challenge the "confidence culture" (Orgad and Gill 2022), rather the "vulnerability works to reinforce it, where brands often introduce insecurity only to replace it with 'defiant individualism' [Orgad and Gill 2022]" (Thelandersson 2023 p3).

McRobbie (2020) described the triangle of "perfect-imperfect-resilience". "Here the perfect encourages women to succeed meritocratically in a highly competitive environment that favours a neoliberal 'leadership-feminism'. The imperfect is then expressed as a response to the 'unviability of the emphasis on success', but it is articulated within severely limited parameters and quickly followed by a resilience that 'springs into existence as a ''bounce-back'' mechanism' [McRobbie 2020]" (Thelandersson 2023 pp3-4).

Thelandersson (2023) used the terms "turn to sadness" to describe the negative feelings expressed by women in 21st century media culture, and "profitable

vulnerability" for "market-friendly iterations of weakness that fit within the otherwise largely positive affective register of mainstream media culture" (p4).

Thelandersson (2023) analysed three media forms to understand the contemporary discussions around "gendered mental health", specifically depression and anxiety, and between 2008 and 2018:

i) Magazine articles about mental health and illness in "Cosmopolitan" and "Teen Vogue".

Thelandersson (2023) gave the overview of a "general increase in coverage in both outlets and the mention of specific diagnoses from 2015 and onwards suggests that mental illnesses were considered to be obvious aspects of contemporary life from that point on. This is significant because in previous eras mental health and illness have been stigmatised subjects that have not been acknowledged as parts of everyday life, and women's magazines have tended to focus on the positive and upbeat, rather than the negative aspects of life" (p90).

"Cosmopolitan" took a tongue-in-cheek approach to the topic, which, Thelandersson (2023) argued, provided "an example of profitable vulnerability in that it aligns itself with the trendy themes of depression, anxiety, and other diagnoses, while maintaining a comfortable distance that avoids striking a too sombre or heavy tone" (p91). "Teen Vogue" had a more serious approach, which "can be seen as giving their readers life-saving information to assist in bettering their mental health" (Thelandersson 2023 p91).

ii) Female celebrities who have spoken publicly about depression and anxiety (eg: Demi Lovato [3]; Selena Gomez) [4].

The key turn was from media speculation about a celebrity's "ailments" to these people talking openly about their experiences. Demi Lovato, in "tell-all documentaries" and music (eg: song called "Sober") described her feelings, and attempts to (successfully) manage and overcome (addiction, bipolar disorder, bulimia). This "fits well with into the dominant 'psychic

[3] Thelandersson (2023) noted "the fact that Lovato came out as non-binary in 2021 and said they use the pronouns they/them does not take away from the fact that the singer was a central figure in early twenty-first-century girl culture" (p217).

[4] Importantly, "in an increasingly intimate media landscape, mental illnesses and other difficulties are acknowledged to show authenticity and build stronger connections with fans and followers, but they then tend to be configured within narratives of self-optimization and improvement so that the overcoming of tragedy gives added cadence to messages of resilience" (Thelandersson 2023 p214).

life' of neoliberalism, post-feminism, and a market-friendly popular feminism" (Thelandersson 2023 p137).

"Lovato's celebrity health narrative shows how mental distress can be successfully folded into a celebrity brand and enhance its market value, as they have been able to make a literal profit off of work that utilises the tragic events in their life while reinforcing a neoliberal ethos of self-work and self-transformation, exemplifying profitable vulnerability" (Thelandersson 2023 p21).

Selena Gomez was seen initially as a "super can-do girl", who subsequently opened up about her experiences of depression and anxiety. "She has largely been cast as a mental health advocate and responsible role model, and her case shows the viability/ marketability of mental health advocacy for a celebrity brand at that point in time. This has been further highlighted in Gomez's makeup line, 'Rare', which is marketed as a mental health aware brand where 1% of sales go to support mental health" (Thelandersson 2023 p137).

iii) Social media and online networks (eg: "sad girls" on "Tumblr" and "Instagram").

Relatability was key in the posts, which included "where the display of vulnerability is often accompanied by something humorous so as to make it less serious" (Thelandersson 2023 p191). Providing and gaining support was also important.

REFERENCES

Dobson, A.S & Kanai, A (2019) From "can-do" girls to insecure and angry: Affective dissonances in young women's post-recessional media Feminist Media Studies 19, 6, 771-786

McRobbie, A (2020) Feminism and the Politics of Resistance: Essays in Gender, Media and the End of Welfare Cambridge: Polity Press

Orgad, S & Gill, R (2022) Confidence Culture Durham, NC: Duke University Press

Thelandersson, F (2023) 21st Century Media and Female Mental Health: Profitable Vulnerability and Sad Girl Culture Cham: Palgrave Macmillan

3. WOMEN'S HEALTH: DIFFERENT TO MEN

3.1. INTRODUCTION

Graham et al (2025) asserted: "It is now well recognised that the inadequate inclusion and consideration of female participants in medical research have led to health inequities, from pre-clinical studies in cells and animals through to human clinical trials. Examples abound of treatments that were never adequately tested in women and were either: inappropriate [lower limb prostheses], ineffective [lecanamab, an Alzheimer's treatment], non-beneficial [implantable cardio-verter defibrillators], or detrimental [thalidomide, an anti-nausea and morning sickness drug]. All of which have a cost, both financial and, more importantly, to patient health" (p1) [5].

The upshot is health research and policies that take account of sex and gender differences. But how to define and operationalise these concepts and terms. Graham et al (2025) explained that sex and gender are "high-level categories used to describe a constellation of characteristics or constructs, each of which exhibit natural variation within the population, may change across the lifespan, and, in the case of gender, are influenced by culture. Sex characteristics may include chromosomes, hormones, or sex organs. Gender comprises identity, behaviour, experiences, social norms, and/or power dynamics. When referring to sex, the terms 'male' and 'female' are typically used, whereas the terms 'girl/women' and 'boy/man' are typically used when referring to gender. Moreover, traditional binary definitions of sex and gender are being revisited. People with variations in sex characteristics (inter-sex), or those who are trans, non-binary, or with other identities

[5] Sewell et al (2022) talked of the "ethical principle of protecting pregnant people, not from research, but through research" (quoted in Gumusoglu and Steizer 2025).

and experiences underscore the breadth of sex and gender modalities" (p1).

A simple solution to the health inequity has been to include more women in research studies. Though this is a good start, Graham et al (2025) emphasised the need for more, including the challenging of "the assumption that the male body is the default" (p1).

Graham et al (2025) were aware of the overall challenge: "Accounting for sex and gender in research, with all this nuance and complexity, is no small feat. Indeed, the challenge, complexity, and imperative that attract some scientists to the study of sex and gender differences can confuse or repel many others, even those who acknowledge the value of rectifying sex and gender imbalances in research" (p2).

3.2. MENTAL HEALTH

3.2.1. Peri-Natal Anxiety Disorders

Schweizer and Graham (2025) noted: "From the covers of parenting magazine to frescos of supremely serene mothers, advertising and most cinematic and visual arts paint the peri-partum as a state of perpetual maternal bliss" (p1). This is an accurate picture for some women, but for many others, "it is also a period associated with increased exposure to stressors (eg: financial impact on earning) and higher levels of perceived stress, which increase throughout pregnancy and peak in the first months of motherhood. Heightened stress levels are reliably associated with increased risk for anxiety disorder symptoms" (Schweizer and Graham 2025 p1).

"Peri-natal anxiety disorders" (PNAD) is rising, but relatively little is known about it. Schweizer and Graham (2025) argued that "peri-natal intrusions" (ie: "intrusive thoughts and images of accidental child-related harm") is a "unique window" into PNAD. An estimated half of mothers will experience intrusive thoughts of intentionally harming their child, according to Fairbrother et al (2022). "These intrusions feel uncontrollable and are extremely distressing to parents. They are also associated with maternal anxiety and with poor child mental health outcomes" (Schweizer and Graham 2025 p1).

Schweizer and Graham (2025) adopted a diathesis-stress model of PNAD. Put simply, stressors and a pre-existing vulnerability to a condition lead to the development of that condition.

Peri-natal intrusions and their distress could be the vulnerability. "Intrusion-related distress is heightened in individuals who show maladaptive appraisals (eg: 'I am a risk to my child'), especially in those with high levels of thought-action fusion (that is, the tendency to equate having a thought about an action with engaging in the action). These parents then are more distressed by infant-related harm intrusions because they believe more strongly that they will hurt their infants, despite research demonstrating this is not the case; the exception are rare forms of post-partum psychosis and suicidal depression, where infant-related harm thoughts can be part of the delusion, becoming compatible with the affected parent's belief system" (Schweizer and Graham 2025 pp1-2). Repetitive negative thinking (ie: a tendency to worry and ruminate on the thoughts) is also relevant.

An example of a particular stressor of recent times is the covid-19 pandemic. "Pandemic-related stress was associated with more symptoms of anxiety and depression during pregnancy [Songco et al 2023], as well as post-partum intrusions up to 22 months post-partum" (Schweizer and Graham 2025 p2). Songco et al (2023) compared over seven hundred pregnant and non-pregnant women.

The cognitive vulnerability during pregnancy and post-partum interacts with hormonal changes at this time. "During pregnancy, the levels of exposure to oestrogens and progesterone are higher than the cumulative exposure to these hormones throughout the non-pregnant lifespan. In the post-partum period, these hormones decline in an acute and dramatic fashion and are coupled with reductions in the stress hormone, cortisol. Hormonal changes, in particular, the sudden decline in oestrogens and progesterone, have been linked to heightened risk for post-partum depression in a subset of women" (Schweizer and Graham 2025 p2).

3.2.2. Peri-Natal Depression

Individuals with a history of depression who become pregnant also have a risk of peri-natal depression (PND). This condition can appear during pregnancy or in the months following birth, and includes symptoms like low mood, feelings of worthlessness, anhedonia (loss of pleasure), and suicidal thoughts. "The consequences of untreated PND include obstetric complications like pre-eclampsia and preterm birth, lower adherence to pre-natal care, and issues extending into the post-partum such as impaired bonding and increased depressive symptoms among

children" (Pritschet et al 2025 p1).

Predicting exactly who will suffer from such a condition would be helped by clear biological markers (eg: changes in the brain). Neuroimaging studies have highlighted changes in the brain during the peri-natal period (pregnancy to one year post-partum) (eg: changes in grey and white matter; Pritschet et al 2024). Such studies "demonstrate that areas of cortex that exhibit the greatest structural changes over the peri-natal period comprise regions that functionally belong to association networks — networks involved in cognitive, emotional, and social processes. Across association networks, the effects of pregnancy appear most prominent in regions that correspond to the default mode network (DMN), a brain network critical for internally directed cognition and emotional processing" (Pritschet et al 2025 p1). There is also some parallel between these changes and alterations in the brain associated with depressive symptoms (Pritschet et al 2025). But "it is not clear how inter-individual differences in association networks present or vary throughout the peri-natal period, nor how they relate to risk of PND" (Pritschet et al 2025 p1).

Pritschet et al (2025) argued for the use of "precision functional mapping", which "delineates the unique spatial layout of brain networks in an individual, ie: their personalised functional networks (PFNs)..." (p1). These researchers explained: "We propose that the combined effort of mapping PFNs before pregnancy and longitudinally charting their trajectory through the post-partum in women at heightened risk of PND holds the potential to improve medical decision-making for patients with depressive symptoms who are pregnant or planning to conceive" (Pritschet et al 2025 p2). There are risk factors for PND beyond brain function, Pritschet et al (2025) accepted, like life experiences, and psycho-social variables.

A longitudinal neuroimaging study involves a number of scans over a period of time to show changes in the brain. Ballesteros et al (2025) did this with 88 fist-time mothers (during late pregnancy and early post-partum) and thirty control women. The researchers concentrated on changes in the volume of the hippocampus and the amygdala areas of the brain.

The main finding was that during late pregnancy the pregnant women had increases in the right amygdala volume compared to the controls, and this change correlated positively with self-reported depressive symptoms. Another finding was that poorer childbirth experiences

negatively correlated with increases in hippocampus volume.

Neuroimaging data were not available prior to pregnancy (ie: baseline measures), and self-reports were used for depressive symptoms, and childbirth experiences (though standardised measures were used [6]). No participants had a formal diagnosis of post-partum depression. Two magnetic resonance imaging (MRI) scans were taken. The first during the third trimester of pregnancy (approximately 36 gestational weeks), and the second within one month after birth. The participants were volunteers in the Madrid area of Spain recruited via "Instagram" and "X" social media channels, or by word of mouth. The researchers were not blinded to the women being pregnant or not.

The mothers and controls were matched for age (average 32-33 years), and IQ/educational level. The standardised MRI methodology was used. The original sample was 110 mothers and 34 controls, but twenty-two mothers and four controls were excluded for various reasons, including that seven mothers could not undergo a second scan due to discomfort, and others had errors during scans (eg: movement by women).

3.2.3. Interactions and Connections

"The interplay between the heart and the brain — mediated through neural, hormonal, and autonomic pathways — is increasingly recognised as central to understanding cardio-vascular risk and neuro-vascular conditions. Both organs are profoundly affected by the neuroendocrine system and hence significantly shaped by sex (and gender)" (Prinsen et al 2025 p1). The menstrual cycle will impact the brain-heart interactions.

The relevant hormones are oestrogen and progesterone, and these hormones have receptors in both the heart and the brain. This is seen in, for example, the heart rate increasing by an average 2-3 beats per minute during the luteal phase of the menstrual cycle (Prinsen et al 2025).

The "historical male bias in clinical research... has left critical gaps in understanding cardiac (patho)physiology..." (Prinsen et al 2025 p2). But where there is research, findings include that, for example,

[6] The "Edinburgh Post-Natal Depression Scale" (Cox et al 1987) (10 items related to past seven days; total scores range from 0 to 30), and the "Birth Experiences Questionnaire" (Saxbe et al 2018) (10 items, each scored 1 to 7).

heart arrythmias are more frequent in women, and particularly during the luteal phase (Prinsen et al 2025).

Another area of interest is sex hormones and medication effectiveness. It has been found that "sex hormones can influence the pharmacodynamics and efficacy of various medications, suggesting the need for dose adjustments tailored to the menstrual cycle phase. For instance, increased beta-blocker dosage may be more effective during the luteal phase when cardiac parasympathetic activity decreases, whereas reduced doses could suffice during the follicular phase" (Prinsen et al 2025 p3).

Prinsen et al (2025) ended: "When studying the brain-heart axis, a field in which clinical sex differences are commonly observed, it is critical to account for ovarian hormone–induced variability" (p3).

Gumusoglu and Steizer (2025) concentrated on brain-immune system interactions through the peri-natal period: "During the transition to motherhood, the maternal immune system strikes a tenuous balance: It must expand tolerance to foreign antigens including those from the half-foreign foetus while also retaining the capacity to combat pathogens. This adaptive shift occurs dynamically alongside neuro-endocrine, neurobiological, and behavioural adaptations. If balance is not achieved, maladaptive immune dynamics prevail, driving obstetric and psychiatric disease, which themselves interact. Pre-eclampsia, pre-term birth, and gestational diabetes all increase risk for mental illness; conversely, peri-natal maternal anxiety and depression are linked to increased risk for antepartum haemorrhage (a 1.5-fold increase), pre-term birth (a 1.61-fold increase), and other pro-inflammatory pregnancy complications. This bidirectional psycho-obstetric risk could be driven, at least in part, by neuro-immune mechanisms" (p1).

3.2.4. Neurological Diseases

Trying to establish sex differences in the healthy adult brain is "a perpetually highly debated topic", and few consistent differences have been found, but, Bonkhoff et al (2025) argued, "when studying the diseased brain, there is little doubt that biological sex plays a key role. Considering incidence alone, most neurological diseases confer substantially differing risks for males and females" (p1).

These researchers reviewed the sex differences in neurological disease, with particular reference to age-associated conditions of Alzheimer's disease (AD), and ischaemic stroke.

First, it is important to establish what would be the biological underpinnings of sex differences in neurological disease. Bonkhoff et al (2025) included the following:

i) Sex-specific genes - eg: Y chromosome-linked genes in biological males.

ii) Sex-specific hormones - eg: oestrogen and progesterone more dominant in females.

iii) Reproduction-related biology - eg: menstrual cycle; pregnancy; menopause.

Looking at the specific neurological diseases now:

1. AD - Two-thirds of sufferers are female, while female carriers of the gene Apolipoprotein E4 (APOE4) have a higher risk of developing AD, particularly at a younger age. Female sufferers have "increased global pathology overall" (Bonkhoff et al 2025 p7) [7].

One hypothesis is that women live longer, while the surviving men are healthier (eg: Mielke et al 2014). Otherwise, sex differences in anatomy, gene expression, and function are "increasingly being recognised" (Bonkhoff et al 2025 p7).

"Another important change thought to contribute to cognitive decline with potential modifications by sex relates to the brain's cholinergic system. It broadly influences sensory, attention, and memory functions and undergoes degenerative changes during physiological and pathological ageing" (Bonkhoff et al 2025 p7).

Using clinical and autopsy data from the US "Rush Memory and Ageing Project", Wood Alexander et al (2025) found that age at menopause was important for future cognitive decline. Earlier menopause interacted with

[7] At the same time, "[A]n increasing body of evidence supports female resilience in brain ageing. Women undergo slower molecular brain ageing, measured by the epigenetic clock, across brain regions, compared to men. Furthermore, women harbour a younger metabolic brain age, measured by positron emission tomography imaging. These findings could underlie the striking observation that women show resilience to cognitive decline and exhibit higher baseline memory functioning in typical ageing of several populations, in the absence of dementia" (Gadek et al 2025 p1). The second X chromosome that women have could explain the differences. Experimental studies have used mice to understand the impact of the second X chromosome on the hippocampus (the area of the brain related to memory) (Gadek et al 2025).

poorer synaptic health to lead to faster cognitive decline.

Post-menopause hormone replacement therapy (HRT) was found to increase the risk of dementia in one large study ("Women's Health Initiative Memory Study") (eg: Shumaker et al 2003). But subsequent re-interpretation of the data suggested a more complex picture (Bonkhoff et al 2025). For example, oestrogen replacement soon after loss of ovarian function may actually be beneficial ("window of opportunity" hypothesis; Davey 2013). "Concurrently, there is the 'healthy cell bias of oestrogen action' theory [Brinton 2008] that is centred on the assumption that oestrogen signalling pathways through mitochondria could have detrimental effects if activated in diseased neurons" (Bonkhoff et al 2025 p8) [8].

2. Acute ischaemic stroke - "Sex differences in ischaemic stroke incidence differ throughout the life span and appear to follow a U-curve. Stroke incidence is higher in younger females, which is likely due to their unique risk profile. In particular, oral contraceptive use and pregnancy-associated complications, such as pre-eclampsia, increase the stroke risk severalfold. Stroke incidence is then higher in males in midlife, before it increases again in females late in life" (Bonkhoff et al 2025 p8). Female sufferers experience higher stroke severity on presentation at hospital as a generalisation.

Rodent studies have examined the role of oestrogen (eg: Carswell et al 2000).

Bonkhoff et al (2025) ended: "Studying sex differences in the diseased brain may help us gain greater understanding of underlying anatomy, mechanical processes, ensuing presentations, and therapy efficacies" (p11).

The researchers accepted the limitations of "considering biological female and male sex as done in this review represents a simplified version of investigating the effects of sex". They explained: "We did not explore the effects of gender or sexual orientation and associated psycho-social and cultural factors on brain organisation and function. These psycho-social and cultural factors, for example, comprise

[8] Using neuroimaging over 3-4 years with women aged 51 to 89 years, Coughlan et al (2025), however, found some impact of HRT on cognitive decline (via faster tau accumulation). But this was so for older women only (ie: above 70 years old). HRT use was self-reported. The data came from the "Harvard Ageing Brain Study", and involved 73 women who used HRT and 73 not. Two PET scans were undertaken at an average of five years apart (range one to 10 years).

lifestyle, help-seeking behaviour, economic power, and access to health care. Gender-related behaviours are assumed to affect epigenetic changes with resulting modifications of sex-related effects. Another limitation may be seen in the fact that we evaluated sex differences in only a binary fashion" (Bonkhoff et al 2025 p12).

3.3. WELL-BEING

Kaiser et al (2025) reviewed the literature on "two paradoxes in women's well-being":

a) "although women today report higher levels of life satisfaction and overall happiness than men, they experience worse outcomes in mental health and negative affect" (Kaiser et al 2025 p1) ("cross-sectional paradox") - Global data covering 168 countries from 2006 to 2023 were analysed here. Around one-third of the countries showed the paradox. So the researchers concluded that the "gender well-being paradox is real but not universal" (Kaiser et al 2025 p5).

Then a number of possible explanations were considered (eg: hormones; culture), and three main mechanisms were found to explain the paradox: "(i) women's greater tendency to experience both positive and negative emotions more intensely; (ii) lower expectations among women compared to men, as well as cultural norms that restrain men from expressing their emotions; and (iii) differences in how men and women use response scales" (Kaiser et al 2025 p10).

b) "despite substantial advances in women's social and economic status over the past 50 years, their well-being relative to men has declined" (Kaiser et al 2025 p1) ("longitudinal paradox") - Long-term data from the USA (1972 to 2022) and Europe (1974 to 2023) were analysed here. It was found that "the paradox is again not universal" (p9), any decline in well-being is "modest" with year-to-year fluctuations. "In terms of negative affect and physical pain, women's relative well-being has significantly fallen across all world regions. Here, the longitudinal paradox appears more consistent" (Kaiser et al 2025 p9).

More widely, in terms of answering questions about women's (and men's) well-being across the world and time, there are methodological and other issues that place limitations on comparisons. These include the role of

expectations, the response scales used to measure well-being, and cross-sectional versus longitudinal data (Kaiser et al 2025).

"The paradoxes in women's well-being emphasise the complexity of gender disparities..." (Kaiser et al 2025 p10).

3.4. ANIMAL STUDIES

"Embryonic development in many species, including case reports in humans, can be temporarily halted before implantation during a process called diapause. Facultative diapause occurs under conditions of maternal metabolic stress such as nursing" (Minder et al 2025 p1). The mouse is an example of facultative diapause, which Minder et al (2025) studied.

They explained that "embryonic development is halted at the blastocyst stage and nidation (ie: implantation of the embryo into the uterine endometrium) is temporarily prevented until conditions become favourable (eg: weaning a litter), allowing for development to resume. During diapause cell division and metabolism within the pre-implantation embryo are maintained at minimal levels, requiring marked changes to halt growth at the level of the entire embryo" (Minder et al 2025 p1).

The hormone oxytocin, which is released in response to the suckling of pups, appears to induce embryonic diapause (Minder et al 2025). For example, the researchers experimentally stimulated oxytocin neurons and delayed gestation.

3.5. REFERENCES

Ballesteros, C et al (2025) Linking birth experience and post-natal depression symptoms to neuro-anatomical changes in hippocampus and amygdala Science Advances 11, eadt5619

Bonkhoff, A.K et al (2025) Sex differences in age-associated neurological diseases - A roadmap for reliable and high-yield research Science Advances 11, eadt9243

Brinton, R.D (2008) The healthy cell bias of oestrogen action: Mitochondrial bioenergetics and neurological implications Trends in Neuroscience 31, 529-537

Carswell, H.V.O et al (2000) Oestrogen status affects sensitivity to focal cerebral ischaemia in stroke-prone spontaneously hypersensitive rats American Journal of Physiology: Heart and Circulatory Physiology 278, 1, H290-H294

Coughlan, G.T et al (2025) Associations between hormone therapy use and tau accumulation in brain regions vulnerable to Alzheimer's disease Science Advances 11, eadt1288

Cox, J.L et al (1987) Detection of post-natal depression. Development of the 10-item Edinburgh Post-Natal Depression Scale British Journal of Psychiatry 150, 782-786

Davey, D.A (2013) Alzheimer's disease, dementia, mild cognitive impairment and the menopause: A "window of opportunity"? Women's Health 9, 279-290

Gadek, M et al (2025) Ageing activates escape of the silent X chromosome in the mouse hippocampus Science Advances 11, eads8169

Fairbrother, N et al (2022) Unwanted, intrusive thoughts of infant-related harm. In Percudani, M et al (eds) Key Topics in Peri-Natal Mental Health Cham: Springer International Publishing

Graham, B.M et al (2025) The power - and complexity - of policy to drive advances in women's health Science Advances 11, eadt0576

Gumusoglu, S.B & Steizer, I.A (2025) Pregnancy as an opportunity to explore brain-immune connections in mental health Science Advances 11, eadu8270

Kaiser, C et al (2025) Two paradoxes in women's well-being Science Advances 11, eadt1646

Mielke, M.M et al (2014) Clinical epidemiology of Alzheimer's disease: Assessing sex and gender differences Clinical Epidemiology 6, 37-48

Minder, J.L et al (2025) Oxytocin induces embryonic diapause Science Advances 11, eadt1763

Prinsen, J et al (2025) The monthly rhythm of the brain-heart connection Science Advances 11, eadt1243

Pritschet, L et al (2024) Neuroanatomical changes observed over the course of a human pregnancy Nature Neuroscience 27, 2253-2260

Pritschet, L et al (2025) Toward personalised clinical interventions for peri-natal depression: Leveraging precision functional mapping Science Advances 11, eadt8104

Saxbe, D et al (2018) The Birth Experiences Questionnaire: A brief measure assessing psycho-social dimensions of childbirth Journal of Family Psychology 32, 2, 262-268

Schweizer, S & Graham, B.M (2025) Peri-natal intrusions: A window into peri-natal anxiety disorders Science Advances 11, eadt2170

Sewell, C.A et al (2022) Scientific, ethical, and legal considerations for the inclusion of pregnant people in clinical trials American Journal of Obstetrics and Gynaecology 227, 805-811

Shumaker, S.A et al (2003) Oestrogen plus progestin and the

incidence of dementia and mild cognitive impairment in post-menopausal women: The women's health initiative memory study: A randomised controlled trial JAMA 289, 2651-2662

Songco, A et al (2023) Social and cognitive vulnerability to covid-19-related stress in pregnancy: A case-matched-control study of ante-natal mental health Journal of Affective Disorders 325, 739-746

Wood Alexander, M et al (2025) The interplay between age at menopause and synaptic integrity on Alzheimer's disease risk in women Science Advances 11, eadt0757