Table S1: Summary of Effects of Serotonin on Aggression

Study Species	Study Results	Evidence of 5HT increasing or decreasing aggression
Vertebrates		
Mice	• *Tryptophan-hydroxylase 2*-deficient (*Tph2*$^{-/-}$) mice exhibited higher aggression in resident-intruder paradigm (Mosienko et al., 2012) • Citalopram (selective 5-HT reuptake inhibitor, SSRI)–injected mice exhibited less aggression (Caldwell and Miczek, 2008) • Male and female homozygous 5-HT transporter (SERT) knockouts exhibited less aggression (Holmes et al., 2002; Heiming et al., 2013) • Suppression of 5-HT firing by genetically overexpressing the Htr1a autoreceptor increased aggression (Audero et al., 2013)	Decreasing
Humans	• Individuals with *tryptophan-hydroxylase 2 (TPH2)* “risk” haplotype exhibited higher aggression levels (Perez-Rodrigues et al., 2010) • Violent antisocial behavior consistently associated with lower 5-HIAA (5-HT metabolite) in cerebrospinal fluid (Moore et al., 2002) • Selective 5-HT reuptake inhibitor (SSRI) treatment reduces measures of impulsive aggression (Coccaro et al., 1997; Reist et al., 2003; New et al., 2004) • Lower SERT distribution (indicating less 5-HT terminals) in anterior cingulate cortex of individuals with impulsive aggression (Frankle et al., 2005)	Decreasing
Rats	• Rats with 5,7-dihydroxytryptamine (5,7-DHT) injections that decreased brain 5-HT levels exhibited higher levels of killing behavior (Vergnes and Kempf, 1982) • Aggression reduced by systemic injections of 5-HT$_{1A}$ agonists (Blanchard et al., 1988; Nikulina et al., 1992) • Systemic 5-HT$_2$ agonists reduce territorial aggression in male rats (Muehlenkamp et al., 1995) • Intracerebroventricular (icv.) infusion of 5-HT$_{1B}$ agonists reduces territorial aggression in male rats (Mos et al., 1992) • Decreased 5-HT release in prefrontal cortex during and after aggressive behavior in male rats (van Erp and Miczek, 2000) • Homozygous SERT knockout male rats display less territorial aggression (Homberg et al., 2007) • Lesioning 5-HT cell bodies in female rats reduces maternal aggression (Holschbach et al., 2018) • Activation of 5-HT$_{1A}$ autoreceptors in dorsal raphe (to suppress 5-HT firing) reduces maternal aggression (da Veiga et al., 2011) • Partial depletion of brain 5-HT increases aggressiveness in naturally low-aggressive male rats (Wallinga et al., 2009)	Decreasing (males) Increasing (females)

Hamsters	• Subcortical brain regions associated with aggression show less 5-HT innervation in highly aggressive male golden hamsters (Cervantes and Delville, 2007) • Intracerebroventricular (icv.) infusions of 5-HT_{1A} agonists decreased aggression in males but not females, while 5-HT_{1B} infusions were ineffective in both sexes (Joppa et al., 1997) • 5-HT_{1A} agonist injections into the hypothalamus inhibited aggression in male Syrian hamsters, but increased aggression in females (Terranova et al., 2016) • Dominant female Syrian hamsters show increased activation of 5-HT neurons in the dorsal raphe (Terranova et al., 2016)	Decreasing (males) Increasing (females)
Prairie Voles	• Fluoxetine (SSRI)-treated males exhibited less aggressive behavior, but fluoxetine-treated females exhibited no changes in aggression (Villalba et al., 1997)	Decreasing (males) No Effect (females)
Birds	• Injections of either fluoxetine (SSRI) or 5-HT_{1A} agonist reduce territorial aggression in male song sparrows (Sperry et al., 2003) • Aggression in known submissive pigeons is increased following partial brain depletion of 5-HT (Ison et al., 1996) • Injections of 5-hydroxytryptophan (5-HT precursor) decrease aggression in dominant pigeons (Fachinelli et al., 1989)	Decreasing
Reptiles	• Fluoxetine (SSRI) injection reduced aggressive responses in male green anole lizards (Deckel, 1996) • Dominant male green anoles treated with sertraline (SSRI) exhibited less aggressive displays (Larson and Summers, 2001) • Baseline 5-HT activity in brain regions associated with aggression is lower in dominant male green anoles (Summers et al., 2005)	Decreasing
Amphibians	• Territorial calling and defense in male coqui frogs are decreased by repeated systemic injections of either fluoxetine (SSRI) or 5-HT_{1A} agonists or 5-$HT_{2A/C}$ agonists (Ten Eyck, 2008; Ten Eyck and Regen, 2014)	Decreasing
Fish	• Atlantic cod fed food supplemented with the 5-HT precursor L-tryptophan (TRP) exhibited less aggressive acts (Höglund et al., 2005) • Rainbow trout fed supplemental TRP exhibited less aggression (Winberg et al., 2001) • Siamese fighting fish and wildtype zebrafish in water treated with fluoxetine (SSRI) demonstrated a lower number of aggressive attacks than controls (Kohlert et al., 2012; Norton et al., 2011) • Male bluehead wrasse injected with fluoxetine (SSRI) exhibited less aggressive behavior than controls (Perreault et al., 2003)	Decreasing
Invertebrates		
Arthropods		

Crustaceans		
Lobsters	• 5-HT-injected squat lobsters (*Munida quadrispina*) exhibited more aggressive postures in isolation and increased territorial aggression towards untreated intruders (Antonsen and Paul, 1997) • Duration and intensity of fights are increased after 5HT injection in American lobsters (*Homarus americanus*, Huber et al., 1997) • Fight winning and territorial possession in juvenile American lobsters (*H. americanus*) are not affected by low dose 5-HT injection, while high dose 5-HT promotes subordination (Peeke et al., 2000) • Discrete aggressive behaviors during intrasexual fights between size-matched juvenile *H. americanus* are increased by injections of 5-carboxamidotryptamine maleate (agonist for 5-HT_1, 5-HT_5, and 5-HT_7 receptors) but decreased by 5-HT injection (Tierney and Mangiamele, 2001)	Generally Increasing
Crayfish	• 5-HT-injected subordinate *Astacus astacus* crayfish were more willing to engage with dominants (Huber et al., 1997) • 5-HT-injected small *Procambarus clarkii* crayfish were more likely to win fights against larger, untreated crayfish, with retention of dominance towards new larger opponents enhanced by fluoxetine (SSRI) (Momohara et al., 2013) • 5-HT injections delay decision to retreat during fights (Bacque-Cazenave et al., 2018) • Chronic 5-HT administration increases fight intensity in size-matched *Orconectes rusticus* crayfish (Panksepp and Huber, 2002)	Increasing
Crabs	• Male *Neohelice granulatus* crabs injected with 5-HT display more approaches and attacks than vehicle-treated opponents (Pedetta et al., 2010) • Male shore crabs (*Carcinus maenas*) that win fights have higher endogenous circulating 5-HT than losers, both at rest and post-contest (Sneddon et al., 2000) • No change in aggression (towards mirror image) following injection of fluoxetine (SSRI) in striped shore crabs (*Pachygrapsus crassipes*, Hamilton et al., 2016)	Generally Increasing
Insects		
Fruit Flies (*Drosophila melanogaster*)	• *TRH-Gal4* driver flies with reduced 5-HT neurotransmission exhibited less aggressive behaviors (Alekseyenko et al., 2010) • Drug-induced increase of 5-HT in fly brain increased aggression (Dierick and Greenspan, 2007) • Drug-induced decrease of 5-HT only modestly lowered fighting frequencies (Dierick and Greenspan, 2007)	Increasing

Stalk-eyed flies (*Teleopsis dalmanni*)	• 5-HTP (5-HT precursor)-treated flies won more contests than untreated flies (Bubak et al., 2014) • Smaller, 5-HT-treated opponents had higher levels of high-intensity aggressive behaviors (Bubak et al., 2015) • 5-HTP-treated flies had a higher probability of winning contests (Bubak et al., 2013)	Increasing
Crickets (*Gryllus bimaculatus*)	• 5-HTP (5-HT precursor)-injected males exhibited more aggressive postures and behaviors (Dyakonova and Krushinsky, 2013) • Male crickets treated with either AMTP (5-HT synthesis inhibitor), 5-HT antagonists, 5-HTP (5-HT precursor) or fluoxetine (SSRI) exhibited no change in aggressive or submissive behaviors during an initial fight (Stevenson et al., 2000; Rillich and Stevenson, 2018) • Injection of AMTP (5-HT synthesis inhibitor) promotes recovery of aggression in losing males, but only after they have fought (Rillich and Stevenson, 2018) • Injection of fluoxetine (SSRI) promotes losing in males (Abbey-Lee et al., 2018)	Mixed, trend for decreasing
Ants	• Oral administration of 5-HTP (5-HT precursor) increases aggression towards non-nestmates in pavement ants (*Tetramorium caespitum*) (Bubak et al., 2016) • 5-HT-administration to *Formica polyctena* ants promoted some aspects of aggressive behavior towards non-conspecifics (*F. fusca*) and potential prey (house cricket nymphs), but had no effect on conspecific aggression (Szczuka et al., 2013) • 5-HT and 5-HTP injections increased percentage of ants (*Formica rufa*) fighting amongst themselves (Kostowski and Tarchalska, 1972) • Endogenous 5-HT decreases in subordinate worker ants (*Harpegnathos saltator*) following formation and reinforcement of social hierarchy (Penick et al., 2014) • Endogenous 5-HT is highest in *H. saltator* ants of the foraging caste, which are known to actively attack intruders (Penick et al., 2014)	Increasing
Honey bees	• 5-HT application increases likelihood of stinging attacks during colony defense (Nouvian et al., 2018)	
Molluscs (Cephalopods)		
Octopus	• MDMA (SSRI) enhanced pro-social (non-aggressive) behaviors (Edsinger and Dölund, 2018)	Decreasing

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