Neurochemical and Behavioural Factors Affecting the Sensitive Period for Imprinting

by

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Abstract

An investigation of the neurochemical properties underlying the sensitive period for imprinting was undertaken by exploring the action of a mixture of an N-methyl-D-aspartate (NMDA) receptor antagonist ketamine (55 mg/kg) and an α_2-adrenergic agonist, xylazine (6 mg/kg) (KX) on the ability of dark-reared chicks to imprint on day 8 post-hatching. Chicks treated with this mixture at 10, 20 or 40 h after hatching and which were reared in the dark were able to imprint on day 8. Controls treated with saline were unable to imprint on day 8. Similarly, chicks treated with the KX mixture or with saline on day 4 or day 7 were not able to imprint on day 8. Two stimuli were used to imprint the chicks; a rotating stuffed hen, and a rotating red and black box. While day 2 chicks were able to imprint on the hen or the box, groups of day 8 chicks that had been treated with KX at 10, 20 or 40 h after hatching only imprinted if they had been exposed to the hen. Box-exposed groups did not imprint. This is not a predisposition-like effect because KX-treated chicks showed a preference for the hen only if they had previously been exposed to it.

Although most of the experiments used dark-reared chicks, the extension of the sensitive period by KX treatment is not restricted to dark-reared chicks. Light-reared KX-treated chicks were also able to imprint on day 8. However, in contrast to dark-reared KX-treated chicks, light-reared KX-treated chicks could imprint on the box or the hen.

There is good evidence that the NMDA receptor system is involved in producing the extended sensitive period. If chicks were given two injections of ketamine (55 mg/kg at 10 h and again at 12 h post-hatching) they could imprint on a hen on day 8 post-hatching. Similarly, chicks treated with MK-801 (5 mg/kg at 10 h post-hatching), a more potent NMDA receptor antagonist, were also able to imprint on a hen on day 8 post-hatching. Chicks given a single dose of ketamine (55 mg/kg), a single dose of xylazine (6 mg/kg) or two doses of xylazine (6 mg/kg at 10 h and again at 12 h post-hatching) were unable to imprint on a box or a hen on day 8 post-hatching. However, there does

appear to be a synergistic action between ketamine and xylazine because the mixture of KX (a single 55 mg/kg dose of ketamine + a single 6 mg/kg dose of xylazine) did extend the sensitive period.

[^{3}H]-MK-801 binding was used to measure the density of NMDA receptors in the intermediate medial portion of the hyperstriatum ventrale (IMHV) of day 8 saline-treated and KX-treated chicks. The density of NMDA receptors in dark-reared KX-treated chicks that received no visual stimulation was significantly lower than the density of NMDA receptors in similarly reared saline-treated chicks. Eight hours after exposure to an imprinting stimulus on day 8, there was an increase in the density of NMDA receptors in the left and right IMHV's of KX-treated chicks. The increase in density of NMDA receptors was significant in the left IMHV of KX-treated chicks, but was not significant in the right IMHV. Thus, on day 8 the underlying neurochemical mechanisms of an imprinting memory in KX-treated chicks appear to share some similarities with imprinting in chicks aged 1-2 days.

It is suggested that treatment with KX at 10, 20 or 40 h after hatching, or treatment with the two doses of ketamine or MK-801, delays a developmental change in NMDA receptors which forms at least part of the system that is responsible for the ability to form an imprinting memory.

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List of Abbreviations

[^{3}H]	tritium
6-OHDA	6-hydroxydopamine
AP5, APV	2-amino-5-phosphonopentanoic acid amino phosphonovalarate
CPP	4-(3(-phosphonoprop-1-yl)piperazine-2-carboxylic acid
dpm	disintegrations per minute
DSP4	N-(2-chloroethyl)-N-ethyl-2-bromobenzylamine hydrochloride
EAA	excitatory amino acid
EPSC	excitatory postsynaptic currents
GABA	gamma amino-butyric acid
h	hour
Hz	hertz
IMHV	intermediate medial portion of the hyperstriatum ventrale
KX	ketamine and xylazine
LSD	least squares difference
LTP	long term potentiation
MK-801	5-methyl-10,11-dihydro-5H-dibenzo[a,d]cyclohepten-5,10-imine
NA	noradrenaline
NMDA	N-methyl-D-aspartic acid
PCP	phencyclidine
PPR	persistent potentiation of the response
PTP	post tetanic potentiation