•综述•

影响认知功能的药物研发进展

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摘要: 神经系统药物在整个药物研发中处于重要地位, 其中调节认知功能的药物更是成为社会发展的迫切需求, 但认知类药物临床供应严重不足且研发面临受挫。本文结合认知药理学的研究现状, 对两大类认知药物进行简要概述, 分别为影响正常认知功能的药物及改善认知功能障碍的药物。目前的新药研发集中在调节神经递质、靶向Aβ和Tau蛋白、神经保护及疏通血管等方面, 仍需要新的研究方法及思路。本文将结合临床及在研药物, 以阿尔茨海默病为主, 提出并分析认知药理学发展的任务和挑战, 总结认知药物研发策略, 指出认知药理学的发展机遇, 以期为广大科研人员提供新思路, 共同促进认知药物的研发与发展。

关键词: 认知药理学; 认知障碍; 促智药; 阿尔茨海默病; 药物研发

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Progress in research and development of cognition related drugs

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Abstract: Nervous system drugs play an important role in the drug research and development, and the cognition related drug become the urgent needs of social development. However, drugs which can regulate cognitive function are seriously inadequate in clinical supply, and faced frustration in research and development process. In this paper, a brief overview of the two types of cognition related drugs (drugs affecting normal cognitive function and improving cognitive dysfunction) were discussed based on the current research status of cognitive pharmacology. The current research and development of new cognition related drugs focuses on regulating neurotransmitters, targeting Aβ and Tau proteins, neuroprotection and vascularization, and still requires new research methods and ideas. In this article, we summed up the research strategies based on the clinical and development of cognition related drugs, especially for the Alzheimer's disease, then we put forward the task and challenge of cognitive pharmacology development. We aimed at providing new ideas for researchers to promote the development of cognitive drugs.

Key words: cognitive pharmacology; cognitive impairment; cognition enhancer; Alzheimer's disease; drug development

长期以来, 神经和精神药理学是药理学的重要分支, 受到广泛重视。防治神经系统疾病和精神疾病的药物在临床广泛应用, 为神经系统疾病和精神疾病的防治提供了重要的物质保障, 至今精神疾病治疗药物在全球的应用量一直保持在领先地位, 也显示出神经精神系统药物的重要性。然而, 其中调节认知功能的药物却由于各种原因影响, 至今依然缺乏, 对其药理学认识也明显不足。

认知科学是一门关系到人的健康状态又复杂的科学。认知药理学 (cognitive pharmacology) 是伴随认知相关药物研究而形成的一门新兴学科, 参与认知科学

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的基础研究。积极开发改善认知功能的药物, 在治疗多种神经精神疾患引起的认知障碍中有重要作用, 对于提升一般条件下人的智能活动也具有重要意义[1]。改善认知功能的药物可以发挥两方面的作用: 一是智能障碍的改善, 二是智能的提高。调节认知功能的药物研究是当前神经精神科学领域的重要方向。

1 认知功能障碍诱发因素及发病机制

认知是指人脑接受外界信息, 经过加工处理, 转换成内在的心理活动, 实现获取知识和应用知识的过程。它包括学习、理解、计算、记忆、判断、表达和执行等复杂的内容。认知障碍是指上述认知功能中的一项或多项受损, 如学习记忆以及思维判断有关的大脑高级智能加工过程出现异常, 从而引起严重的学习、记忆障碍, 同时伴有失语、失用、失认和失行等病理改变。

现在已认识到, 认知的脑结构基础是大脑皮层[2], 其中, 额叶皮层、顶叶皮层和颞叶皮层为主要区域。额叶皮层负责自主运动, 书写、记忆、创造性思维、判断、远见和社会责任感等复杂的智力活动; 顶叶皮层主要负责对感觉信息的高级加工和整合; 颞叶皮层中的海马和蓝斑结构参与记忆加工, 损伤时引起空间或情感记忆障碍等。

任何引起大脑皮层功能和结构异常的损伤因素均可导致认知障碍, 如慢性脑损伤、慢性全身性疾病如心血管病变[3]、精神心理异常及人文因素等, 并以脑损伤为最主要因素。脑损伤涉及的主要因素包括神经退行性疾病, 如阿尔茨海默病[4]、帕金森病[5]、脑血管病[6]、颅脑外伤[7]、颅内炎症、脑发育障碍、脑老化[8]、遗传因素[9]和中毒等。

认知障碍的发病机制主要包括以下方面: ① 脑组织调节分子异常。认知障碍患者常伴随神经递质及其受体异常, 如多巴胺[10]、去甲肾上腺素[11]、乙酰胆碱、谷氨酸, 以及神经肽异常及神经营养因子缺乏; ② 脑组织蛋白质异常聚集。常见于一大类脑神经细胞退行性变性疾病中, 如帕金森病 (Parkinson's disease, PD)、阿尔茨海默病 (Alzheimer's disease, AD)[12,13]、亨廷顿病 (Huntington disease, HD) 和海绵状脑病 (Creutzfeldt-Jokob disease, CJD) 等。原因包括基因异常、蛋白质合成后的异常修饰和脑组织慢病毒感染等; ③ 能量耗竭和酸中毒。无氧酵解引起脑组织缺血性乳酸酸中毒, 细胞 Na^+-K^+泵功能受损, K^+大量外溢, 同时 Na^+、Cl^-及 Ca^{2+}大量内流引起脑细胞损伤, 乳酸堆积还引起神经胶质和内皮细胞的水肿坏死, 加重缺血性损害; ④ 细胞内 Ca^{2+}超载[14]。大量 Ca^{2+}沉积于线粒体, 干扰氧化磷酸化, 造成能量产生障碍; 过度激活 Ca^{2+}依赖的中性蛋白水解酶, 破坏神经细胞骨架; 激活磷脂酶 A 和磷脂酶 C, 使膜磷脂溶解; 脑血管平滑肌 Ca^{2+}超载, 使血管阻力增大, 扩大脑梗死面积, 内皮细胞 Ca^{2+}超载, 内皮间隙扩大, 产生血管性脑水肿; ⑤ 自由基损伤[15]。过度生成的氧自由基破坏细胞膜, 使蛋白酶失去活性, 并可导致细胞变异或者基因突变; ⑥ 炎症细胞因子损害[16]。中枢系统可产生多种多效性细胞因子, 当致炎因子占主导地位时, 会加重脑缺血损害, 同时致炎因子激发吞噬细胞增加, 吞噬细胞既能释放细胞因子刺激修复, 又能释放神经毒素杀伤存活的神经元。

2 影响认知功能的药物

目前研究的影响认知功能的药物大概有两类, 一是改善认知功能的药物, 主要指对多种疾病引起的认知障碍状态进行治疗的药物; 二是影响正常认知功能的药物, 又分为提高认知能力的药物 (促智药) 和损害认知的药物, 前者可用于各种原因引起的认知功能低下状态的预防和治疗, 而后者可以导致记忆缺失或引起幻觉反应, 需要严加监管, 以发挥其有益的治疗作用。这些药物的研究, 构成了认知药理学的主要内容。

2.1 改善认知障碍的药物 这类药物主要用于防治由疾病或其他原因引起的认知障碍状态, 包括创伤引起的认知障碍, 血管性痴呆、阿尔茨海默病和发育不良性的认知障碍等, 但目前这些药物并不能满足临床需求[17]。特别是针对改善认知障碍的药物药理学研究, 依然是非常薄弱的环节, 关于认知的神经递质学说[18-20]、神经可塑性学说[21-24]、信号转导学说、遗传药理学说、表观药理学说[25-27]等, 都不能全面阐明产生认知障碍的机制和药物作用的途径。

目前临床应用改善认知障碍的药物主要分为神经递质调节剂、抗氧化剂、抗炎药、脑血管扩张剂、钙离子拮抗剂和脑代谢复活物等。以阿尔茨海默病的治疗为例, 被临床研究证实有确切提高痴呆患者认知功能的药物仅有两类: 一类是乙酰胆碱酯酶抑制剂 (AChEI); 另一类为谷氨酸受体调控剂——盐酸美金刚。这两类药物虽然能改善患者的认知功能, 但并不能阻止病情发展[28]。治疗血管性痴呆时, 临床选择扩张血管药物作为一线用药, 虽可缓解认知功能, 但药物并不直接作用于神经系统。因此, 这类药物的作用非常局限, 治疗效果差强人意。现将临床用药归纳总结如表 1。

2.2 影响正常认知功能的药物 对于认知功能不存在缺陷的人, 在用药过程中也会出现认知能力的改变。这些药物可以分为两类: 一类是提高认知能力的药物; 另一类是干扰认知能力的药物。前者通常称为促智药 (nootropic drug)[29], 而后者产生的作用也有多种, 如导致记忆障碍、兴趣降低和幻觉等, 这些药物多作为工具药用于研究中。

Table 1 Clinical drugs for the treatment of cognitive disorders. AD: Alzheimer's disease; PD: Parkinson's disease; HD: Huntington disease

Classification	Common name	Mechanism	Indication
Acting on neurotransmitters			
Cholinergic system	Donepezil Tacrine Galantamine Huperzine A	Inhibit the acetylcholinesterase	Improve memory cognitive ability in AD patients
	Ivastagmine Rivastigmine	Inhibit the acetylcholinesterase and butyrylcholinesterase	Improve memory cognitive ability in AD patients
	Vasopressin	Activate the central nicotinic cholinergic system	Treat the memory impairment caused by traumatic brain injury
	Citicoline	Choline donor	Treat the schizophrenia memory impairment
	Choline-*L*-alfoscerate	Biosynthesis precursor of acetylcholine	Improve memory cognitive ability in AD patients, delay memory loss in patients with craniocerebral injury or brain stroke
Dopamine system	Levodopa	Dopamine supplementation	Improve cognitive decline in PD patients
	Carbidopa	Peripheral decarboxylase inhibitors which reduce peripheral decarboxylation of levodopa	Improve cognitive decline in PD patients
	Modafinil	Increase the dopamine release in the brain	Promote awakening as a cognitive enhancer
Adrenal system	Methylphenidate	Inhibit monoamine oxidase; increase the release of norepinephrine and dopamine	Improve attention deficit in patients with brain injury, AD and HD
	Imipramine	Inhibit the reuptake of adrenaline and 5-HT, improving mood	Improve cognitive awareness in depressed patients and obsessive-compulsive patients
Glutamic acid system	Memantine	Antagonize *N*-methyl-*D*-aspartate (NMDA) receptor	Improve memory cognitive ability in AD patients
Antioxidants	Selegiline	Inhibit the type B monoamine oxidase selectively	Improve cognitive decline in PD patients
	Melatonin	Endogenous antioxidant	Improve cognitive impairment caused by epilepsy and cerebral ischemia
	Edaravone injection	Inhibits lipid peroxidation as free radical scavenger, thereby inhibiting oxidative damage of brain cells, vascular endothelial cells, and nerve cells	Improve cognitive impairment in patients with cerebral infarction
Cerebrovascular dilating agent	Betahistine	Dilatate cardiovascular and cerebrovascular blood vessel, especially vertebral artery system	Adapted to amnestic mild cognitive impairment
	Vinpocetine	Inhibit the cerebral vascular smooth muscle calcium-dependent phosphodiesterase selectively, dilate the cerebral blood vessels, increase cerebral blood flow and improve cerebral circulation	Improve mild cognitive dysfunction
Calcium channel antagonist	Cinnarizine Flunarizine Nimodipine Nitrendipine	Dilated blood vessels as selective calcium antagonist	Improve cognitive impairment in patients with schizophrenia
Brain metabolism activator			
Ergot base derivative	Dihydroergotoxine Nicergoline	Block alpha receptors, expand blood vessels, strengthen brain cell metabolism, and enhance protein biosynthesis	Improve cognitive function in patients with AD, multiple infarct dementia, and schizophrenia
γ-Aminobutyric acid derivative	Piracetam Pramiracetam	Activate and protect brain neurons, improve various types of cerebral hypoxia and brain damage, and up-regulate glutamate-related receptor function	Improve cognitive function in patients with AD, multiple infarct dementia, and schizophrenia
	Oxiracetam	Exciting ACh, regulate the central glutamate system, activate PKC activity in the hippocampus, and promote energy metabolism in brain tissue	Treat the neurological deficits, memory and mental disorders caused by brain damage
	Aniracetam	Enhance neuronal synaptic phospholipase activity, increase the formation and transport of brain ATP, increase the synthesis of protein and RNA, and promote brain utilization of amino acids, phospholipids, glucose, and oxygen	Improve cognitive function in patients with AD and cerebrovascular disease
VitB6 derivative	Pyrithioxine	Promote glucose and amino acid metabolism in the brain, and improve systemic assimilation	Adapted to memory loss, inattention of AD patients, concussion and encephalitis

Continued

Classification	Common name	Mechanism	Indication
Neurotrophic drugs	Ganglioside	As an essential elements of brain nerve regeneration, mediate the activity of nerve growth factor, form a new rich neural network, repair and promote the development of brain nerves	Improve cognitive impairment in patients with cerebral infarction
Anti-hypoxia drugs	Duxaril	Increase blood oxygen concentration by allylpiperazine	Treat the symptoms associated with cognitive and chronic sensory nerve damage in the elderly (excluding AD)
Neuropeptide	Cerebrolysin	Enhance cholinesterase and adenylate cyclase activity, increasing the supply of glucose and peptides in the brain	Improve cognitive function in patients with Alzheimer's and ischemic stroke
Others			
	Indeloxazine	Resurrect the spontaneous brain waves in the cerebral cortex, improve memory and concussion-induced mobility disorders	Improve memory
	Ginkgobiloda	Improve cerebral blood circulation, anti-inflammatory, anti-oxidation and membrane protection	Improve cognitive awareness in patients with Alzheimer's, vascular dementia, and schizophrenia
	ST-200	Assist in the transport of fatty acids into the mitochondrial matrix	Improve memory
	Estrogen	Increase the release of choline acetyltransferase, reduce Aβ deposition, regulate glucose metabolism and cerebral blood flow	Improve memory cognitive ability in AD patients

曾有人对提高智力的药物进行研究, 但确证有效的药物还非常有限。常用的中枢兴奋剂, 如尼古丁[30]、咖啡因和茶碱等, 可引起暂时性认知功能的提高, 但没有证据表明能够提高人类的智能, 促智药的研发还需要更深入的研究。

损害人正常认知的药物通常是药物的不良反应。这些药物主要有: 可引起记忆缺失的药物, 主要为作用于中枢的麻醉药物如氯胺酮[31]、苯二氮䓬类药物地西泮等, 胆碱能受体拮抗药物如山莨菪碱等; 引起感情淡漠学习兴趣降低的药物, 主要为抗精神病药物如氯丙嗪等。另外, 还有一些具有致幻作用的药物, 也能干扰人的认知功能。

3 改善认知功能的药物研发现状

人类的认知功能是一个复杂的系统, 既涉及神经药理学研究内容, 也与精神药理学关系密切; 既有其特定的物质基础, 又有着独特的表现形式。人的认知能力是其物质基础的行为表现, 无论这一基础是遗传性的或是后天获得的, 干预其物质基础和调控过程, 都有可能产生行为学表现, 从这个角度分析, 药物调控人的认知功能是可能的, 但需要对其药理学作用机制加以深入研究。因此, 研究认知药理学还需要长期积累, 在技术方法改良及理论创新的基础上, 积累更多的认知知识, 达到有效调控人类认知功能的目标。

由于人们对中枢系统的认识有限, 加以临床检验标准的局限性, 目前新药研发主要集中在改善认知障碍, 且重点为改善中枢神经系统代谢和调节病理过程, 如改善脑供血的药物、保护神经功能的药物和促进受损伤神经修复的药物等。到目前为止, 能够改善认知功能障碍的药物还非常有限, 不仅数量少, 而且疗效也需要进一步验证。目前的新药研发在传统思路上引入了新的作用机制和靶点, 进入Ⅲ期临床试验的药物集中在调节神经递质 (胆碱、*N*-甲基-*D*-天冬氨酸受体和5-HT为主)、靶向Aβ和Tau蛋白等。另外, 一些主要发挥神经保护及疏通血管作用的化合物也大量进入Ⅱ期临床试验, 且近些年靶向疫苗及抗体得到重视。现主要参考Drugbank、Thomson Reuters Integrity、药渡数据库及文献检索, 将已进入Ⅲ期及Ⅱ期临床试验的改善认知的在研药物汇总于表2、3, 以便为广大科研人员提供更多研发促认知药物的新思路。

4 改善认知功能药物研发的趋势

目前在改善认知方面, 除作用于经典途径Aβ[32]和Tau蛋白[33]外, 调控递质水平[34-36]、补充神经营养因子[37,38]、加强神经保护[39]等均成为研究的热点。同时, 胶质细胞源性神经营养因子 (glial cell-derived neurotrophic factor, GDNF)[40]、磷酸二酯酶(phosphodiesterase, PDE)、一氧化氮合酶(nitric oxide synthase, NOS)、NOGO-AC (引起轴突新分支凋亡的髓鞘蛋白, 一旦被抑制能修复神经连接恢复知觉和运动能力)、TRPⅥ(与人疼痛有关的神经系统受体, 能增加记忆和神经可塑性)[41]等作为新的靶标用于寻找新型认知改善药物。

Table 2 Cognition enhancers entering phase III clinical trials

Classification	Drug (research and development institution)	Mechanism
Acting on neurotransmitters		
Regulate choline	Zanapezil (Takeda)	Acetylcholinesterase inhibitor
Regulate NMDA	Neramexane (Merz)	NMDA receptor antagonist
Regulate 5-HT	NS-2330 (NeuroSearch)	5-HT, NA, DA triple reuptake inhibitor
	Lu-AE58054 (Lundbeck)	5-HT-6 receptor antagonist
Targeted tau protein	LMTX™ (TauPx)	Tau protein aggregation inhibitor
Targeting Aβ amyloid	Gantenerumab (Roche)	Aβ amyloid inhibitor
	MABT-5102-A (Gnentech)	Decomposition of amyloid plaque
	IVIG (GlaxoSmitkline)	
	3-APS (Bellus)	
Acting on secretase	EGCG (Charit)	α-Secretase activator
	MK-8931 (Merck)	β-Secretase inhibitor
	Pioglitazone (Takeda)	
Others	Pitavastatin (Kowa)	Cholesterol synthesis inhibitor
	Simvastatin (Merck)	
	AC-1204 (Accera)	Glucose stimulant

Table 3 Cognition enhancers entering phase II clinical trials

Classification	Drug (research and development institution)	Mechanism
Acting on neurotransmitters		
Regulate choline	TC-5619 (Targacent)	α7 nAChR agonist
	DMXB-A (Comentis)	
	GTS-21 (Athenagen)	
	EVP-6124 (Envivo)	
	RG3487 (Roche)	α7 nAChR antagonist
	ABT126 (AbbVie)	
	AZD1446 (Targacept)	$\alpha 4\beta 2$ nAChR agonist
	ABT560 (AbbVie)	
	C-1734 (Targacent)	
	ST101 (Sonexa)	Acetylcholine stimulant
	R-Phenserine (Axonyx), NP-61 (Neuropharma)	Acetylcholinesterase inhibitor
	Bisnorcymserine (QR Pharma)	Butyrylcholinesterase inhibitor
Regulate NMDA	Dimeben (Medivation)	NMDA receptor antagonist, cholinesterase inhibitor
Regulate 5-HT	GSK-239512 (GlaxoSmithkline)	5-HT-3 receptor antagonist
	PRX-03140 (Eplx/GlaxoSmithkline)	5-HT-4 receptor agonist
	SB-742457 (GlaxoSmithkline)	5-HT-6 receptor antagonist
	AVN101 (Avineuro)	
	GSK-742457 (GlaxoSmithkline)	
	PF-05212365/0512377 (Prifer)	
Rugulate histamine	ABT-288 (Abbvie)	Histamine receptor agonist
	PF-03654746 (Prifer)	
	AZD-5213 (AstraZeneca)	
Rugulate monoamine oxidase	Ladostigil (Ladostigil)	Brain MAO-A and MAO-B inhibitors, simultaneously inhibiting AChE and BuChE
	RG-1577 (Roche)	Monoamine oxidase inhibitor
	Tesofensine (NeuroSearch)	
Regulate GABA	SGS742 (Bristol-Myers Squibb)	Selective GABA-B receptor antagonist
Regulate AMPA	Coluracetam (Braincells)	AMPA receptor agonist
	LY-451395 (Lilly)	
	CX-717 (Cortex)	
Rugulate Sigma	LX6171 (Lexicon)	Membrane proteins expressed only in the central nervous system, whose activity is associated with synaptic vesicles and presynaptic membranes
	NGX267 (Torreypines)	M_1 receptor agonist, reducing neurotoxic protein production
	ACP-104 (Acadia)	Partial agonists of dopamine D_2 and D_3 receptors with weak activation
	DAS-431 IV (DrugAbuse Sciences)	Dopamine D_1 receptor agonist

Continued

Classification	Drug (research and development institution)	Mechanism
Neurotrophic factor	T-817MA (Toyama Chenical)	Protect the brain and supplement the nutrients needed for brain cells
	AIT-082 (Neo Therapeutics)	Nerve growth factor (NGF) stimulator
	CERE-110 (Ceregene)	
	ECB-AD (NsGene A/S)	Cell therapy, coat cell bio-presenting device and secret NGF
Neuroprotective agent	AL-108 (Allon Therapeutics)	Combine microtubule end binding proteins 1 and 3, prevent neurofibril bundle formation, prevent and repair brain cell death
	MITO-4509 (MitoKor)	Affect mitochondrial metabolism, protect nerves, and reduce beta-amyloid
Targeted tau protein	Lithium salt (National Institute of Neurological Diseases and Stroke)	Glycogen synthase kinase-3β
Targeting Aβ amyloid		
Aβ aggregation inhibitor	PPI-1019 (Praecis)	Aβ inhibitor
	BAN2401 (Eisai)	
	Crenezumab (Genentech)	
	ARC029 (Archer)	
	UB-311 (United Biomedical)	
	PF-04494700 (Prifer)	Advanced glycation end product inhibitor
	PF-04360365 (Prifer)	
	PBT2 (PranaBiotech)	Metal ion chelating agent
Targeted vaccine and antibody	ELND-005 (Speranaza)	Aβ monomer binding, aggregation inhibitor
	AD01/02 (Affiris/GSK)	Induce antibody-specific attack on the N-terminal fragment of Aβ, active immunization
	CAD106 (Novartis)	
	Gantenerumab (Roche)	
	ACC-001 (Elan)	Composed of Aβ1-6 short peptide conjugated diphtheria toxin carrier protein CRM197, active immunization
	PF-04360365 (Prifer)	Specific attack on the C-terminal fragment of Aβ, passive immunization
	Larenflurbil (Myraid)	Selectively reduce the amyloid plaque
Acting onsecretase	Acitretin (TargeMol)	α-Secretase activator
	APH0703 (Aphios)	
	Simvastain (Merck)	
	Tamibarotene (Toko Hong Kong)	
	Bryostatin-1 (Agennix)	
	RO5313534 (Roche)	
	MK-8931 (Merck)	β-Secretase inhibitor
	Pioglitazone (Takeda)	
	NIC5-15 (Mount Sinai)	γ-Secretase modulator
	EVP-0962/6124 (En Vivo)	
	CHF5072	
Others	ST-101 (Sonexa Therapeutic)	CAM kinase stimulant, activate T-type voltage-gated potassium channels
	TTP488 (Transtech)	Advanced glycation end product receptor (RAGE) inhibitor
	MEM-1003 (Bayer)	Phosphodiesterase PDE4 inhibitor
	CERE-110 (Ceregene)	Delivery of the nerve growth factor (NGF) gene *in vivo* by an adeno-associated viral vector (AAV) delivery system
	Colostrinin (ReGen Taherapeutics)	The antibody-rich product derived from the milk component secreted by the first birth mother, dissolving the gelatinous fiber plaque in the brain
	SAR110894 (Sanofi)	H3 antagonist
	Rilapladib (GlaxoSmithKline)	LP-PLA2 antagonist
	MSDC-0160 (Metabolic Solutions)	mTOT modulation insulin sensitizer
	APH0371 (Aphios)	Protein kinase C stimulator

对于提高正常智能的新药研究, 虽然目前以不良反应居多, 但也提供了依据和线索。张钧田等[1]指出, 此类药物可从调控神经递质、神经肽和激素、提高细胞内钙浓度或适当释放一氧化氮、增加灰质和白质含量、上调

神经细胞和GDNF表达, 以及提高海马神经发生和突触新生等方面加强研究。通过研究调控认知功能的物质基础和神经活动的过程, 有可能达到提高人类认知能力的效果, 但目前更为重要的是准确合理应用这些药物。

此外, 人参[42]、丹参[43]、黄皮、益智和远志[44]等多种中药已经作为保健品在市场上销售, 从中获得的有效成分经研究结果显示都具有一定的改善认知作用。在中医药领域, 能够益智的药物和方剂很多, 调节心智的方法也非常丰富, 这些长期积累的资料和信息, 在认知新药开发中有着不可或缺的作用, 也是我国药理学家研究认知药理学的优势。

5 展望

提高认知功能一直是人们的追求, 随着人们对健康的重视和各类智能产品如智能机器人的不断出现, 改善和调节智能的药物将成为社会新的需求。时下针对改善认知障碍及提高智力的临床药物尚缺乏, 研发多由特定疾病发病机制或病理表现出发, 取得一定治疗效果, 但尚无一种药物可直接改善并提高认知功能, 其失败的原因可能在于对药物本身作用机制认识不足, 以及对认知系统认识不够清晰。相信随着对认知的不断认识, 对机制的不断了解及对药物研究和临床经验的不断积累, 治疗认知障碍及提高人类智能的药物终将越来越丰富, 一个充满智慧的和谐社会将成为中华民族复兴的重要标志。

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