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空气污染对个体直接和溢出行为的影响*

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摘 要 空气污染对行为影响的研究日渐丰富, 且大致分为两个方向: 一是与环境健康有关的直接行为, 二是与之无直接相关的社会行为(溢出行为)。基于此, 在回顾空气污染对两种行为影响研究的同时, 进一步综述了用于解释直接行为产生机制的计划行为理论和健康行动过程取向模型, 以及用于解释社会行为机制的焦虑与自我损耗。而更全面的探究现象背后的机制有助于发现更多有效应对空气污染的举措, 未来的研究可以采用更多纵向的研究范式、增加对行为机制的探究, 从而改善人们的风险应对行为。

关键词 空气污染; 直接行为; 溢出行为; 环境心理学

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1 前言

空气污染已经成人类共同面对的难题, 对人类的身体健康和心理健康造成了长期危害。在身体健康影响方面, 已有的医学证据表明, 短期和长期暴露于空气污染均可导致急性和慢性健康问题(Seaton, Godden, MacNee, & Donaldson, 1995)。例如, 空气污染导致约 420 万人死于心脏病、中风、肺病和慢性呼吸道疾病(WHO, 2018)。而在心理健康方面, 也有大量研究表明, 包括NO_2(Welsch, 2006)、SO_2(Ferreira et al., 2013; Luechinger, 2010)、PM_{10} (Levinson, 2012)和$PM_{2.5}$(Du, Shin, & Managi, 2018)等空气污染因素对人们的幸福感和心理健康都造成了显著的负面影响(Yuan, Shin, & Managi, 2018)。同时, 空气污染还进一步降低了快乐感, 增加了人们抑郁症状的发生率(Zhang, Zhang, & Chen, 2017)。

近年来, 随着空气污染问题逐渐为人们所重视, 空气污染对行为影响的研究也日渐丰富。有研究显示, 空气污染既影响了与环境健康相关的直接行为, 如防御行为(Zhang & Mu, 2018)、健康行为(Roberts, Voss, & Knight, 2014)等; 也影响了与环境健康并不直接相关的社会行为, 即溢出行为, 如旷课(Marcon et al., 2014)和攻击性行为(Rotton & Frey, 1985)等。然而, 以往有关空气污染的综述多将关注的焦点放在空气污染对人类心理的整体影响上, 并未对空气污染导致的行为改变做出更为细致的梳理。因此, 本文将关注点放在空气污染对行为影响的相关研究成果上, 首先从行为改变的视角阐述了空气污染与直接行为和溢出行为的关系; 其次, 分别从直接和溢出行为出发重点分析空气污染对人们行为的内在影响机制; 最后就空气污染及其相关环境风险问题的未来研究方向提出展望。

2 空气污染对直接行为的影响及相关机制

空气污染对个体行为的影响首先体现在人们与环境健康相关的一些直接行为上, 如防御行为(Zhang & Mu, 2018; An & Yu, 2018)、健康锻炼行为(An & Xiang, 2015)、移居(Qin & Zhu, 2017)、旅游(Cheung & Law, 2001)和绿色消费(Zhao, Zhang, & Wang, 2019)等。在空气污染对直接行为的影响机制的探索上, 计划行为理论(Theory of

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Planned Behavior, TPB) (Ajzen, 1991)和健康行动过程取向模型(Health Action Process Approach, HAPA) (Luszczynska & Schwarzer, 2003)则为研究者提供了切入点。

2.1 防御行为

购买口罩和空气净化器：由于口罩和空气净化器能够有效减少个体与污染空气的接触(Langrish et al., 2012; Morishita, Thompson, & Brook, 2015), 因此在室外佩戴防霾口罩、在室内使用空气净化器成为大多数居民的选择(Johnson, Mol, Zhang, & Yang, 2017; Liu, He, & Lau, 2017; Wang, Zhao, Zhang, Niu, & Ma, 2018)。从网络搜索结果上看, 当 $PM_{2.5}$ 浓度超过 250 μg/m^3 时, 北京的防霾口罩及空气净化器的搜索量分别增加 110%~162%、79%~132% (Liu et al., 2017)。网购数据也显示空气污染会增加人们购买两类产品的花费(Sun, Kahn, & Zheng, 2017)。当空气质量指数(Air Quality Index, AQI)每上升 100 点, 防霾口罩的支出就会增加 70.6%, 所有口罩的支出将增加 54.4%; 当 AQI 指数从 105 增加到 205, 中国一天购买防霾口罩和空气净化器等类似产品的成本将高达 80247 美元, 其中 38356 美元来自于防霾口罩(Zhang & Mu, 2018)。Qiu 等人(2018)也证实了雾霾会促使人们采取戴口罩、安装空气净化器的行为。然而, 在两类产品的选择上, 净化器则更受居民欢迎, 调查的北京市 1050 名居民中超过 60%的人都报告使用空气净化器, 但只有 34%的人报告雾霾天会戴口罩(Johnson et al., 2017)。此外, 在对北京 1961 名居民调查中, 研究发现约有一半的受访者没有在雾霾天戴口罩(贾培, 蔡利国, 2014)。

减少户外时间：元分析研究(An, Zhang, Ji, & Guan, 2018)发现, 空气污染对健康行为的不利影响主要表现为减少了人们户外活动的时间(Ban, Zhou, Zhang, Brooke, & Li, 2017; Lercher, Schmitzberger, & Kofler, 1995; Yu, Yu, Gordon, & Zhang, 2017), 尤其是对于有呼吸系统疾病(Bresnahan, Dickie, & Gerking, 1997; Wells, Dearborn, & Jackson, 2012; Wen, Balluz, & Mokdad, 2009)和有雾霾相关病症的人(Bresnahan et al., 1997)更是如此。首先, 研究者对不同群体的调查都发现空气污染会减少步行时间。例如, Yu, An 和 Andrade (2017)以退休人员为研究对象, 发现 $PM_{2.5}$ 浓度每增加一个标准差(56.6 μg/m^3), 每周步行时间减少 4.69 小时。An 和 Yu (2018)以大学生为研究对象发现, $PM_{2.5}$ 浓度每增加一个标准差(36.5 μg/m^3), 一周总步行时间减少 7.3 分钟, 日均睡眠时间增加 1.07 小时。

其次, 空气污染也会减少人们的其他出行方式。当空气质量警报发布时, 自行车流量将减少 14%~35% (Saberian, Heyes, & Rivers, 2017)。一项关于美国部分地区 10 年间空气质量警报有效性的研究也发现, 市中心的交通流量随空气污染警报显著下降 2.1% (Saberian et al., 2017; Tribby, Miller, Song, & Smith, 2013)。即使需要外出, 居民也会驾车来防御污染物, 例如, 波兰和休斯敦地区的 1962 名居民中约 85%~90%人不会在空气质量差时减少驾驶等行为(Semenza et al., 2008), 说明人们不仅不会在雾霾警报日减少开车(Noonan, 2014), 甚至更愿意开私家车阻隔空气污染的危害(Ban et al., 2017; Neidell, 2009)。但是, 也有研究发现相反的结果, 人们并未在污染严重时明显减少户外活动的时间(Alberini & Krupnick, 2000), 特别是周末户外活动的时间(Alahmari et al., 2015)。

购买健康保险：人们还会通过购买健康保险这种长期的自我保护手段来减少对空气污染的担忧。研究者通过对 2012 年到 2015 年超过一百万份健康保险合同的研究发现, 空气污染越严重, 人们对健康保险的需求越大; 而如果在购买保险的冷静期(投保人签订订单后在一定时间内, 如果对所购买的保险不满意, 可以无条件退保)中空气污染水平低于签订订单日的污染水平, 那么健康保险的取消率就会上升(Chang, Huang, & Wang, 2018)。

2.2 健康锻炼

研究显示空气污染也会减少人们在闲暇时的锻炼时间(An & Xiang, 2015; Roberts et al., 2014; Wen, Balluz, Shire, Mokdad, & Kohl, 2009)。当 $PM_{2.5}$ 浓度增加时, 被试报告的跑步、健美操和打高尔夫球等时间都会相应减少(An & Xiang, 2015; Roberts et al., 2014)。每周的剧烈身体活动和中强度身体锻炼也随着 $PM_{2.5}$ 浓度每增加一个标准差(44.72 μg/m^3)分别减少 22.32 分钟和 10.63 分钟(Yu, Yu et al., 2017)。这些锻炼的减少也导致了居民的患病率(Booth, Gordon, Carlson, & Hamilton, 2000; Wen, Balluz, Shire et al., 2009)和住院率的上升(Moretti & Neidell, 2011)。但是, 也有文献持不同

观点, 例如, 研究者在空气污染是否会导致大学生久坐行为上就存在截然相反的意见(An & Yu, 2018; Yu et al., 2018)。不仅如此, 空气污染对健康锻炼行为的影响也存在性别差异, 当 PM_{10} 每增加 10 μg/m^3 时, 美国女性的马拉松比赛成绩会降低 1.4%, 而男性的成绩却未受影响(Marr & Ely, 2010)。

2.3 移居

空气污染水平也是人们在评定理想居所时不可忽视的重要因素(Marques & Lima, 2011; Nelson, 1978), 为了保护自己免受空气污染的危害, 部分居民会因环境问题而选择移居(Elliott, Cole, Krueger, Voorberg, & Wakefield, 1999; Hunter, 2005)。研究者分析了我国 153 个城市居民搜索“移民”的百度指数发现, 若当日 AQI 指数上升 100 个点, 有关移民的搜索量会在翌日增加 2.3%~4.8%, 该影响在重度污染(AQI > 200)时表现更为明显(Qin & Zhu, 2017)。Chu 等人(2017)调查了湖北武汉某儿童医院的儿童父母后发现, 空气污染知识较为丰富的父母具有更高的移居意愿, 即那些对空气污染了解越多的人移居意愿越强烈。此外, 在对京津冀地区不同行业的工作者研究中发现, 雾霾风险感知中的身体健康、心理健康风险感知均正向预测工作者的迁移意愿, 而政府控制感知反向预测工作者的迁移意愿(Lu, Yue, Chen, & Long, 2018)。由此说明, 空气污染使得个体感知到身心健康受到了居住环境的威胁(Mahmood, 2011), 这种威胁不仅促使个体采取自我防御, 更促使其希望通过移居杜绝空气污染(Chen & Rosenthal, 2008), 而如果政府能够更好的控制雾霾则可降低移居意愿(Lu, Yue et al., 2018)。

2.4 旅游

旅游业的发展受到空气污染带来的自然资源耗竭的阻碍(Sajjad, Noreen, & Zaman, 2014)。研究指出风险感知对访问目的地的意愿具有显著的负面影响(Becken, Jin, Zhang, & Gao, 2016; Zhang, Zhong, Xu, Wang, & Dang, 2015)。基于 2005~2016 年间北京的入境和境内旅游数据分析发现, 空气质量好时(二级及以下)的游客量明显多于空气质量差时(三级及以上)的游客量(Zhou, Jiménez, Rodríguez, & Hernández, 2019)。在 Chen, Lin 和 Hsu (2017)的研究中也发现了类似的结果, 随着糟糕的空气质量天数(PSI > 100)每增加 1 天, 在日月潭旅游的高峰期间游客数量将减少 25725 人。另有研究者发现雾霾警报促使到洛杉矶动物园(Los Angeles Zoo)和格里菲斯公园天文台(Griffith Park Observatory)游玩的人数减少(Neidell, 2009, 2010; Zivin & Neidell, 2009)。但研究者基于 2002~2008 年英国布里斯托尔动物园(Bristol Zoo Gardens)参观人数的研究发现, 空气污染警报只是减少了当地游客的访问量, 而对外地访客未造成显著影响(Janke, 2014)。

研究显示空气污染不仅有即时效应, 也有滞后效应。Wang, Fang 和 Law (2018)通过分析中国 11 个城市网上旅行社的出境旅游订单数据, 发现过去 7 天的平均 AQI 指数每增加一个单位, 出境旅游人数增加约 13 人, 说明当地空气质量差会增加人们未来几天的出境旅游量, 以躲避污染。空气污染感知对入境旅游总量也有显著的滞后负面影响, 空气质量较差的 5 个月后, 入境游客的数量显著降低(Xu & Reed, 2017)。然而, 该滞后效应也存在争议, 研究显示当连续两天发布雾霾警报时, 人们会选择忽视第二天的警报, 景点访客量并未减少(Zivin & Neidell, 2009)。

2.5 绿色消费

空气污染程度也影响着消费者的绿色消费偏好。研究者将人们的绿色消费行为分为习惯性绿色消费行为(Habitual green consumption behavior, HGCB)和投资性绿色消费行为(Invested green consumption behavior, IGCB)。研究发现, 雾霾污染感知与两种消费行为均呈正相关(Zhang, Guo, Bai, & Wang, 2019), 即, 当居民感知到雾霾越严重, 就越愿意购买健康和环境友好产品(无论是日常用品还是需投入一定资金的绿色产品)。该结论在购买节能家电上也得到佐证(连锋, 2016), 雾霾越严重, 居民购买节能家电的意愿就越强烈(Zhao et al., 2019)。

然而, 这种影响也并非完全一致, 具体到购买环保/非环保汽车行为上, 居民的绿色消费行为随着空气污染的程度变化表现有所不同。随着空气污染加重, 相对于空气污染加重程度较高城市的消费者, 空气污染加重程度相对较低城市的消费者更愿意转向购买更环保的汽车(Li, Moul, & Zhang, 2017)。而在购买非环保汽车上, 空气污染对购买低效能汽车的影响则受到城市收入的调节作用, 低收入的城市中, 低效能的汽车销售量先随 AQI 指数的增加而减少, 但当 AQI 指数到达一

定阈值后，低效能汽车的销售量随 AQI 指数的增加反而上升；而在收入水平较高的城市，空气污染越高，人们越不愿购买低效能汽车(Li et al., 2017)。

2.6 对直接行为影响机制的探索

综上所述，多数研究都显示，空气污染影响了人们与环境健康相关的直接行为，然而遗憾的是，以往有关空气污染影响直接行为的研究多集中在现象描述上，较少深入探讨对这些行为的影响机制。在已有的机制研究上研究者大都借鉴了与健康行为相关的模型，其中最主要借鉴的是计划行为理论(Ajzen, 1991)与健康行动过程取向模型(Luszczynska & Schwarzer, 2003)。

2.6.1 计划行为理论

计划行为理论为人们预测行为提供了一个界定清晰的模型，通过个人对行为的态度、主观规范和感知行为控制预测其行为意图，进而预测其在特定情境下的具体行为(图 1) (Ajzen, 1991)。具体而言，个人的行为意图随着个人对行为的态度、主观规范和感知行为控制的增强而增强，个人行为实施的可能性也随之提升。鉴于计划行为理论具有普遍的适用性(Chan & Lau, 2002; Shi, Wang, & Zhao, 2017)，其被应用于各种行为改变领域，在与空气污染有关的环保行为研究中得到广泛应用(Hung, Chang, & Shaw, 2019; Zahedi, Batista-Foguet, & van Wunnik, 2019)，不同的研究者分别将其应用到减少温室气体排放(Shi et al., 2017; Zahedi et al., 2019)、佩戴口罩(Hansstein & Echegaray, 2018)、购买绿色产品(Afroz, Masud, Akhtar, Islam, & Duasa, 2015; Taufique & Vaithianathan, 2018)等行为中。例如，Afroz 等人(2015)基于该理论模型探究了消费者购买可减少空气污染环保车的行为，结果表明，消费者购买环保车的态度、主观规范、感知行为控制和购买意图均正向预测了购买行为。

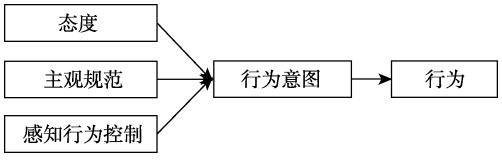

图 1 计划行为理论模型(Ajzen, 1991)

2.6.2 健康行动过程取向模型

Schwarzer 指出在计划行为理论中没有考虑意图转化为行为时个体所面临的障碍(如与不良习惯的冲突等)，所以意图对行为的直接预测并不是最佳预测，需要其他因素弥补意图到行动之间的鸿沟，故提出了健康行动过程取向模型(Lippke, Ziegelmann, & Schwarzer, 2010; Luszczynska & Schwarzer, 2003; Schwarzer, 2016)，并用于解释空气污染问题(Schwarzer, 2016)。该模型提出行动的产生需要两个阶段：导致行为意图的前意图动机阶段和导致实际行为产生的后意图意志阶段。在动机阶段，风险知觉和积极结果预测了意图的形成。在意志阶段，意图转变成追求目标行为的详细计划，进而预测行为的产生。值得一提的是，计划分为行动计划和应对计划，行为控制作为一种自我调节策略维持着追求目标行为的状态。除此以外，基于前一阶段的行动型自我效能和基于后一阶段的应对型自我效能、恢复型自我效能在两阶段中分别起着重要的作用(图 2) (Schwarzer, 2008, 2016)。在应用上，有研究者将健康行动过程取向模型用于研究雾霾天气下佩戴口罩的动机和潜在因素，并发现自我效能和风险感知正向预测了人们佩戴口罩的意图，计划和行动控制在意图和佩戴口罩之间起到了中介作用(Schwarzer, 2016; Zhou et al., 2016)。

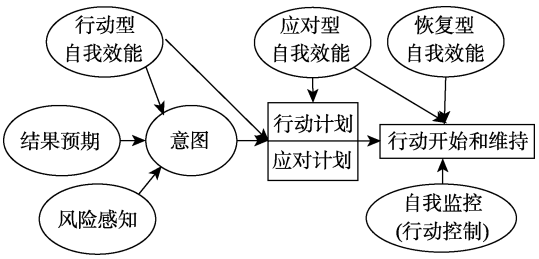

图 2 健康行动过程取向模型(Schwarzer, 2008, 2016)

值得注意的是，目前有关机制的探讨还较为初步：缺少从环境心理学视角(而非健康行为视角)出发的系统化、理论化探讨；同时，在机制研究上更多偏重认知成分的作用，而忽视了情绪变量的影响。因此，未来研究需要综合考虑这些问题，进一步构建以类似环境风险问题为基础的理论和机制模型。

3 空气污染对溢出行为的影响及相关机制

空气污染不仅会影响直接行为，还会溢出影

响到与环境健康问题并不直接相关的一些社会行为上, 如旷课行为(Chen, Guo, & Huang, 2018)、攻击行为(Perera et al., 2013)、犯罪行为(Younan et al., 2018)、股票投资(Demir & Ersan, 2016)和工作行为(Zivin & Neidell, 2012)等。目前有关空气污染对溢出行为影响机制的文章还较为少见, 但研究者已经开始探讨两者间的中介关系, 如焦虑(Lu, Lee, Gino, & Galinsky, 2018)和自我损耗(Fehr, Yam, He, Chiang, & Wei, 2017)的相关作用。

3.1 旷课行为

学生旷课的人数会随着空气污染等环境风险的增加而增加(Currie, Hanushek, Kahn, Neidell, & Rivkin, 2009)。Berman 等人(2018)发现美国环境保护局风险筛查环境指标(Risk-Screening Environmental Indicator, RSEI)的对数每增加一个单位, 公立学校小学生的长期旷课率增加 3.40%, 中学生增加 8.09%。而且此影响存在长期的滞后性, Liu 和 Salvo (2018)对中国 6545 名国际学校的儿童进行了为期 1234 天的跟踪, 发现空气污染的严重程度导致儿童的旷课行为, 与持续 14 天空气质量达标的情况相比, 连续 14 天暴露在 $PM_{2.5}$ 高于 200 μg/m^3 的情况下, 学生的旷课率会增加 0.9%。此外, 对 3139 所学校学生考勤记录的研究发现, 空气污染通过影响儿童的健康导致入学率下降, 此影响至少可持续 4 天, 且呈单调递增的模式, 即 AQI 指数每增加一个标准差, 缺勤率将提高 6.99% (Chen et al., 2018)。也有研究者基于 2007~2010 三个学年的日旷课记录发现, 暴露于高浓度的 $PM_{2.5}$ 环境中两天后的旷课率显著增加(1.2%~3.5%) (Marcon et al., 2014)。Zhang 等人(2018)采用日记法研究发现, 旷课前三天的 $PM_{2.5}$ 平均值与缺课显著正相关。Mohai, Kweon, Lee 和 Ard (2011)也发现, 空气污染与美国密歇根州一些公立学校学生的低出勤率、不良身体健康状况有关。该州空气污染最严重地区公立学校的学生出勤率最低, 且该校在国家教育考试中不及格的比例也最高。

3.2 攻击行为

空气污染的加重会导致人们做出更多攻击行为。在一项针对儿童攻击行为的研究中, 研究者对 248 名来自燃煤地区非吸烟妇女的孩子进行了跟踪调查(从儿童出生前一直跟踪研究到他们 9 岁), 发现儿童的攻击行为受到空气污染元素多环芳烃的影响, 特别是在母亲道德低下的条件下, 攻击行为随着多环芳烃暴露的增加而增加的程度更高(Perera et al., 2013)。研究者在大学生群体中也发现了类似结果, Jones 和 Bogat (1978)以非吸烟大学生为被试, 发现二手烟烟雾比清新空气环境更易引发被试的攻击性。同样以大学生为被试, 研究者发现当被试分别处于中度恶臭(乙硫酸、硫化铵)和无恶臭的环境中时, 前者比后者更能激发更高水平的攻击行为(Rotton, Frey, Barry, Milligan, & Fitzpatrick, 1979)。此外, 由于高污染的空气可能含有更多较大的、低流动性的离子以及较少的、小的、高流动性的离子, 研究者研究了负离子对攻击行为的影响, 结果发现暴露在中等或高水平负离子下的 A 型人格被试对同伙的攻击要比只暴露在低离子水平下被试的攻击性更强(Baron, Russell, & Arms, 1985)。

3.3 犯罪行为

空气污染的加重还会导致更多犯罪行为。基于 2001~2009 年期间美国联邦调查局(FBI)的犯罪数据进行分析, 研究者发现空气污染显著预测了犯罪事件, 犯罪事件随着空气污染的增加而上升(Lu, Lee et al., 2018)。在 2006~2013 年间, 美国部分地区的 $PM_{2.5}$ 每增加 10%, 该地区的暴力犯罪则增加 0.14%(Burkhardt et al., 2019)。更多的研究揭示了空气污染对青少年犯罪行为的促进作用(Bondy, Roth, & Sager, 2018; Forns et al., 2016; Younan et al., 2018)。一项 $PM_{2.5}$ 对青少年违法行为的纵向研究也给出了充分的证据, 研究者以出生于 1990~1995 年、年龄在 9~18 岁的双胞胎为研究对象, 发现父母报告的青少年的违法行为随所处环境中 $PM_{2.5}$ 浓度的增加而增加(Younan et al., 2018)。另外, Haynes 等人(2011)的研究也发现, 1999 年某些空气污染物的排放与 2003 年至 2005 年青少年犯罪的判决结果之间存在显著的正相关关系, $PM_{2.5}$ 和 PM_{10} 排放量的自然对数每增加一个单位, 分别使得青少年犯罪的判决风险增加了 12%和 19%。Burkhardt 等人(2019)研究发现, 如若每天减少 10%的 $PM_{2.5}$ 和臭氧, 每年可以节省治理犯罪成本 14 亿美元。但 Burkhardt 等人也发现空气污染与犯罪之间的关系会因犯罪类型而存在差异, 空气污染只增加了暴力犯罪, 而与财产犯罪无关。

3.4 股票投资

空气污染对投资股票行为的影响既出现在发

达国家(Levy & Yagil, 2011), 也出现在发展中国家(Zhang & Tao, 2018)。空气污染对股票交易造成负面影响(Demir & Ersan, 2016; Lepori, 2016), 会显著地增加投资者的处置效应(在持有亏损资产的同时出售盈利资产) (Shefrin & Statman, 1985)。该负面影响还体现在回报率上, Levy 和 Yagil (2011)发现在控制其他变量的情况下, 空气污染与美国四家证券交易所股票回报率呈负相关, 但此关系随着证券交易所与污染地区之间距离的增加而减弱。Wu, Hao 和 Lu (2018)对中国 1548 家股份公司的数据研究发现, AQI 指数越高, 股份公司的收益、营业额、波动性均越小, 表明当地企业的交易量随城市空气污染的增加而减少: 当空气突然恶化时(AQI >150), 当天的千股交易量比前 5 天的平均千股交易量减少 10.13%。Zhang 和 Tao (2018)基于万得数据库(WIND database)的股票指数数据也发现, 在控制注意力滞后性后, 投资者对雾霾的注意力越高, 中国三个主要的股票市场(上证交易指数、深证交易指数、创业板指数)的收益越低。然而, Li 和 Peng (2016)基于 2005 年至 2014 年的整个中国股市的研究发现, AQI 指数与企业的股票收益无关、甚至呈滞后的正相关。基于不一致的结果, He 和 Liu (2018)指出股票交易是否因空气质量而变化受条件影响, 只有当环保意识提升时, 空气污染才会对股票交易行为产生显著的负作用, 例如在 2008 年的绿色奥运后, 公众的环保意识提高, 空气污染对股票波动性和流动性的影响由正向转为负向, 降低了股市的交易程度。

3.5 工作行为

以往研究者基于不同工作人群研究了空气污染对生产力的影响(Hanna & Oliva, 2015), 发现空气污染不仅会降低室外的劳动生产力(Zivin & Neidell, 2012), 也会造成室内生产力的下降(Chang, Zivin, Gross, & Neidell, 2016)。例如, Zivin 和 Neidell (2012)在 155 天内跟踪调查了约 1600 名农场工人, 发现即使臭氧水平在国家标准以下, 臭氧浓度每降低 10 ppb, 工人生产力也会提高 5.5%。He, Liu 和 Salvo (2019)研究了中国江苏和河南两地纺织厂工人生产力水平日常波动情况, 发现长时间暴露在污染环境中会对生产力造成显著的负面影响, 当日及前 25 日的 $PM_{2.5}$ 平均每增加 10 μg/m^3, 日均产量减少 0.5%~3%。Chang, Zivin, Gross 和 Neidell (2019)获取了携程国际旅行社 2010 年至 2012 年在上海和南通的呼叫中心工作人员在工作日内接听电话的时间, 研究发现空气污染指数(Air Pollution Index, API)每上升 10 个单位, 工人每天接听的电话量减少 0.35%。空气污染对生产力的不良影响在运动员身上也得到了验证, 在对德国足球甲级联赛 1999~2011 年间的 2956 场比赛统计中发现, 随着空气中悬浮颗粒浓度每增加 1%, 足球比赛中的传球数量则相应下降 0.02% (Lichter, Pestel, & Sommer, 2017)。空气污染对患病儿童家长的影响更另人担忧, 基于 2007~2009 年秘鲁首都利马家庭调查(the Peruvian National Household survey, ENAHO)发现, $PM_{2.5}$ 每减少 10 μg/m^3, 家中有患病儿童的工作者一周的工作时间将增加 1.9 个小时(Aragón, Miranda, & Oliva, 2017)。

3.6 对溢出行为影响的机制

研究者很早就开始关注到空气污染对溢出行为的影响, 在研究的方法上也力求多样, 但却鲜有研究探讨空气污染对于溢出行为影响的机制, 目前人们主要探索了空气污染与溢出行为之间的中介关系, 其中最常被提及的中介变量是焦虑(Lu, Lee et al., 2018)和自我损耗(Fehr et al., 2017)。

3.6.1 焦虑的中介作用

焦虑是对潜在的不良后果做出反应时的痛苦或生理唤醒状态(Brooks & Schweitzer, 2011)。以往研究显示, 空气污染会导致一些不那么严重但非常频繁的消极情绪(Rotton & Frey, 1985), 而这些消极情绪可能会进一步造成生活满意度降低和心理幸福感损害(相鹏, 耿柳娜, 周可新, 程枭, 2017; Dolan & Laffan, 2016)。例如, 现有研究发现空气污染会导致焦虑(Power et al., 2015)、抑郁(Cho et al., 2014)、烦扰(Claeson, Liden, Nordin, & Nordin, 2013)等消极情绪的滋生。目前有关消极情绪在空气污染与行为间中介关系的探讨中多集中于有关焦虑的研究。Greenberg 等人(2003)发现空气污染会增加人们的焦虑, 而焦虑会导致人们做出更多不道德行为(Corrigan & Watson, 2005; Kouchaki & Desai, 2015)。甚至有研究表明, 即使只在心理上体验了空气污染(想象生活在雾霾天气的环境里)的被试, 其焦虑感也会提升, 并导致其采用不道德谈判策略的程度更高(Lu, Lee et al., 2018)。

3.6.2 自我损耗的中介作用

根据自我损耗理论(Ego Depletion Theory), 自我控制资源是所有需要心理能量活动的共同资源(Baumeister, Bratslavsky, Muraven, & Tice, 1998), 而这些资源是有限的, 在缺乏足够恢复机会的情况下, 个体的自我控制能力会逐渐枯竭(Baumeister & Vohs, 2007)。由于空气污染作为一种不安全的环境对人类造成威胁、对居民的生活造成压力(Yuan et al., 2018)、助长了人们的悲观情绪(Lima, 2004; Marques & Lima, 2011), 所以个体为了中和这些消极认知而克制对空气污染不良影响的思考, 而这种克制反而会提升对被压制思想的专注(Wegner, Schneider, Carter, & White, 1987), 从而导致自我控制资源的损耗, 趋使个体更加关注个人利益而表现出不道德的行为(Gino, Schweitzer, Mead, & Ariely, 2011)、非利他行为(任俊 等, 2014)等。实证研究已经发现自我损耗在空气污染对溢出行为的影响中起到中介作用, 例如, 当员工自我控制特质程度较高时, 空气污染评价促进了员工的自我控制资源损耗, 进而减少了员工的组织公民行为、增加了员工的怠工行为(Fehr et al., 2017)。

综上所述, 上述研究似乎向我们表明空气污染给人们心理带来的资源损耗与情绪扰动, 造成人们不能专心完成其他社会行为, 从而产生溢出性影响。然而, 具体的机制验证仍需研究者未来的进一步探讨。

4 研究小结与展望

随着空气污染为人们所重视, 相关行为研究逐渐增多, 人们研究的视角也从对个体的直接行为影响的探究扩展到对其溢出行为影响的研究, 而且研究者也开始对相关机制进行思考。然而现有研究还存在一些问题: 首先, 有关空气污染的行为研究及其机制缺乏系统化、理论化的探讨; 其次, 研究方法较为单一局限, 以横断面研究为主; 最后, 有关行为改善的干预研究较少。针对以往研究的不足, 我们认为未来研究还需要在以下几个方面继续深化:

4.1 扩展空气污染对直接和溢出行为影响机制的探索

当前有关空气污染影响行为的研究更多关注在对于现象的揭示上, 而在影响机制的探索和相关理论建立方面则鲜有探讨。如前文所述, 在直接行为的影响机制领域, 研究者更多借鉴了健康行为改变模型的成果, 从计划行为理论(Hansstein & Echegaray, 2018; Shi et al., 2017)和健康行动过程取向模型(高雯, 杨丽珠, 李晓溪, 2012; Chow & Mullan, 2010; Scholz, Sniehotta, & Schwarzer, 2005; Wiedemann, Schuz, Sniehotta, Scholz, & Schwarzer, 2009)出发, 对人们受到空气污染后的直接行为进行了探讨。然而, 这些模型均探讨了认知和行为之间的关系, 但却未提及情绪的重要作用。以往有关环境风险的研究揭示, 情绪对行为改变的影响起着重要作用(Slovic, Finucane, Peters, & MacGregor, 2004), 空气污染导致的消极情绪亦可成为解释直接行为产生机制的重要通路。例如, 学者在空气污染对股票交易的研究中提到情绪的波动对投资行为有着重要影响(He & Liu, 2018; Li & Peng, 2016)。因此, 基于现有的各项模型, 未来的研究可以在构建环境心理学领域的直接行为影响机制模型时, 考虑构建认知–情绪的双通路模型。

此外, 在对溢出行为影响的机制探索中, 研究者显然还处在初步阶段, 现有研究也只是分别探究了焦虑(Lu, Lee et al., 2018)和自我损耗的中介机制(Fehr et al., 2017)。这些研究似乎向我们表明空气污染给人们心理带来的资源损耗与情绪扰动是影响溢出行为的关键。那么, 未来的研究除了可以进一步发掘空气污染等环境问题对于各领域溢出行为的影响外, 还有必要对于引发行为的心理机制进行系统化研究。如果从相似的心理机制入手, 那么, 其他类似能够给人们心理带来资源损耗和情绪扰动的研究领域(如睡眠缺乏), 则有可能为我们未来对于环境问题所造成的溢出行为及其机制探讨给予更多启示。

4.2 提倡动态研究与经验取样

在空气污染领域中, 以往研究多固守于传统的横断面取样法(An & Xiang, 2015; An & Yu, 2018; Younan et al., 2018), 而缺乏对实际行为的动态性研究。所谓经验取样(Experience Sampling Methodology)是指多次收集人们在较短时间内对生活中经历事件的瞬时评估, 并对其进行记录的一种方法, 该方法作为一个更接近“事实”的数据收集方法, 为研究者提供了收集实时数据的工具(张银普, 骆南峰, 石伟, 2016; Fisher & To, 2012), 代表了数据收集技术的巨大的进步。常见的经验

取样法有日记法(Daily Diary) (Bolger, Davis, & Rafaeli, 2003)、生态瞬时评估法(Ecological Momentary Assessment, EMA) (Stone & Shiffman, 1994)和日重现法(Day Reconstruction Method, DRM) (Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004)等。需要注意的是空气污染和其导致的心理行为是实时变化的，传统的横断面取样显然无法准确评估这种变化。运用经验取样法不仅能够更好的捕捉人们随空气质量变化的心态，而且该方法还有利于研究者探究被试在自然真实空气污染情境下的心理状态，能够保证较好的生态效度。近年来，有关空气污染的研究已经开始尝试采用经验法进行取样。例如，研究者(Zhou et al., 2016)采用多阶段取样的方法，构建健康行为过程取向模型，探讨了空气污染对戴口罩行为的影响。Zhang 等人(2018)则采用日记法，通过让学生每日记录自己的缺课和上课时的情况来研究空气污染对旷课率的影响。这种从动态性视角出发的研究，为我们了解空气污染如何影响人们的行为提供了更为扎实的证据。

4.3 增加应对污染行为方案的探究

从以往研究来看，虽然人们在空气污染中会采用一些自我保护行为，但是亦有不少研究显示，人们的这种自我保护行为显然是不够充分的(贾培，蔡利国, 2014; Johnson et al., 2017)。即使在知道口罩可以有效防护雾霾的情况下，但由于不舒服和怕麻烦，人群中只有不到 40%的人选择在空气污染日佩戴口罩(Johnson et al., 2017)。同时，尽管人们能够认识到保护环境是解决空气污染问题的根本有效途径，但人们在环保行为上的表现却并不理想(Li et al., 2017; Semenza et al., 2008)。这些结论提示我们有必要增加空气污染领域的干预研究，进一步探索哪些方案能够促使人们的行为发生真正改变(Zhou et al., 2016)。

目前，已有研究开始从传统风险管理的层面探讨应对人们行为的可能干预方案，例如研究显示政府制定的空气污染物总排放量的标准(Yuan, Zhang, Wang, Wang, & Zuo, 2017)可以显著降低人们的污染排放。研究还显示可以通过给学生提供免费公交车票、增加交通拥堵高峰期时的里程费等市场奖惩措施(Bamberg & Schmidt, 2001; Rufolo & Kimpel, 2008)从而降低人们驾驶私家车的频率。此外，近年来区别于传统社会治理手段，低成本且非强制性的助推策略也为空气污染领域的社会治理提供了一条可行的心理学路径(张书维，梁歆佚，岳经纶, 2019)。例如，研究者通过为期 2 个月发送每日的空气质量状况的短信促使孕妇增加了自我保护行为(Jasemzadeh, Khafaie, Jaafarzadeh, & Araban, 2018)，以 APP 的形式实时呈现空气污染信息促使人们从常走的路线转而选择空气污染更少的路线(Ahmed, Adnan, Janssens, & Wets, 2019)。上述结论为我们今后的工作提供了借鉴，未来研究既可以从传统风险管理方法入手，亦可借用已有的助推手段，对促进人们提高自我保护和环境保护行为的改善方案进行综合、系统的探索。

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Effects of air pollution on individuals' direct and spillover behaviors

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Abstract: Depending on how closely it connects with environmental health, behavioral response as a result of air pollution can be classified into two types: direct behavior and social behavior (or spillover behavior). In this regard, this paper reviewed previous literature on how air pollution influences these two types of behaviors. Further, we summarized several mechanisms underlying these two behaviors. Specifically, the Theory of Planned Behavior and the Health Action Process Approach were proposed to model direct behavior; anxiety and ego depletion were proposed to predict social behavior. More comprehensive investigations into the behavioral mechanisms will benefit future designing of more effective measures against air pollution. Future researchers may consider adopting a longitudinal paradigm and conduct in-depth analyses of behavioral mechanisms, in order to improve individuals' behaviors in response to risks.

Key words: air pollution; direct behaviors; spillover behaviors; environmental psychology