Lithiation of 1-arylimidazol-2(1*H*)-ones and 1-aryl-4,5-dihydroimidazol-2(1*H*)-ones

Carme Cantos Llopart, Conchita Ferrer, and John A. Joule

Abstract: 1-Arylimidazol-2(1*H*)-ones are shown to be readily lithiated, using 2 mol equiv. of *n*-butyllithium, on the benzene ring, ortho to the heterocycle. 1-Aryl-4,5-dihydroimidazol-2(1*H*)-ones also undergo metalation on the aromatic substitutuent ortho to the heterocycle, but less efficiently. 1-Aryl-3-methylimidazol-2(1*H*)-ones are lithiated on the heterocyclic ring and then on the benzene ring ortho to the heterocycle. No ortho-directing effect was found for 1-aryl-4,5-dihydro-3-methylimidazol-2(1*H*)-ones.

Key words: ortho-lithation, ureas for directed ortho metalation, 1-arylimidazol-2-ones, 1-arylimidazolidin-2-ones.

Résumé : On a démontré que les 1-arylimidazol-2(1*H*)-ones, sous l'action de 2 équivalents molaires de *n*-butyllithium, subissent facilement une réaction de lithiation sur le noyau benzénique, en position ortho par rapport à l'hétérocycle. Les 1-aryl-4,5-dihydroimidazol-2(1*H*)-ones subissent aussi une métallation sur le substituant aromatique ortho par rapport à l'hétérocycle, mais la réaction est moins efficace. Les 1-aryl-3-méthylimidazol-2(1*H*)-ones subissent une réaction de lithiation sur le noyau hétérocyclique avant de procéder à une lithiation sur le noyau benzénique en ortho de l'hétérocycle. On n'a pas observé d'effet d'orientation vers la position ortho avec les 1-aryl-4,5-dihydro-3-méthylimidazol-2(1*H*)-ones.

Mots clés : lithiation en ortho, urées pour des métallations orientées en ortho, 1-arylimidazol-2-ones, 1-arylimidazolidin-2-ones.

[Traduit par la Rédaction]

Introduction

We have described (1) our investigations into the use of the heterocyclic substituent in 1-arylpyrimidin-2(1*H*)-ones and in 1-aryl-3,4,5,6-tetrahydropyrimidin-2(1*H*)-ones to assist lithiation at an ortho position (2, 3). In the former case, the use of the pyrimidinone as a directing group was foiled by its strong tendency to undergo addition of the lithiating reagent. In the case of the six-membered cyclic ureas (1-aryl-3,4,5,6-tetrahydropyrimidin-2(1*H*)-ones), we showed that the substituent has a weak ortho directing effect (1). Our study was designed to produce intermediates for a route (4), alternative to those (5–7) previously described, to the biologically active variolin group (8) of alkaloids. The route will allow flexibility and easy introduction of diverse analogues for subsequent biological assessment. We have now examined the analogous five-membered compounds as a further element of eventual diversity in this context.

In the work described here, we have demonstrated the formation and exploitation of intermediates that are summarized as **1** and **2**, formed from **3** and **4**, implying significant ortho-directing effects in these cyclic ureas, which we believe have considerable potential in synthesis. We have also examined the lithiation of *N*-methyl analogues, **5** and **6**, and found no ortho assistance in the case of the latter; the former underwent lithiation in the heterocyclic ring and then ortho to the heterocycle. We are aware of no other attempts to use imidazolones or 4,5-dihydroimidazolones as ortho-directing groups in this way.

Aside from our own work (1), there are only two reports of the use of ureas as ortho-directing substituents, and in both of these, the urea was acyclic. Quéguiner and co-workers (9) lithiated *N*,*N*-dimethyl-*N*′-(quinolin-3-yl)urea with lithium di-isopropylamide leading to the 2-lithio derivative as the thermodynamic product. Smith et al. (10) used 2.5 equiv. of *n*-butyllithium or *tert*-butyllithium at 0 °C to deprotonate *N*-aryl-*N*′,*N*′-dimethylureas ortho to the urea unit; in some cases, the use of *tert*-butyllithium led to lithiation at *N*-methyl as well as, or instead of, ring lithiation.

Carpenter and Chadwick (11) examined the lithiation of five-membered aromatic heterocycles carrying a 1,3-dimethylimidazolidin-2-yl substituent at an α-position and found a weak ortho-directing effect. Earlier, it had been shown that in 1,3-dimethyl-2-phenylimidazolidine, efficient ortho lithiation of the phenyl ring is possible with *n*-butyllithium at room temperature (12). Simig and co-workers (13) demonstrated ortho lithiation in 2-aryl-2-methyl-1,3-dioxolanes; when a meta-chlorine was present on the benzene ring, lithiation took place at the carbon between the chlorine and the ketal-directing groups.

Following the efficient ortho lithiation of 2-phenylimidazoline (14), Chadwick and Ennis (15) examined 2-(2-heteroaryl)imidazolines and confirmed a strong ortho-directing effect. With an appropriate choice of lithiating agent (*sec*-BuLi–TMEDA at –78 °C) ortho lithiation of 2-(2-

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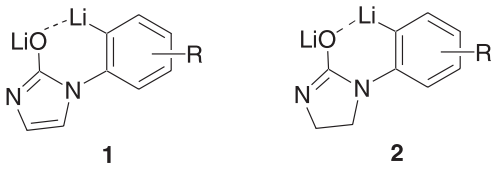
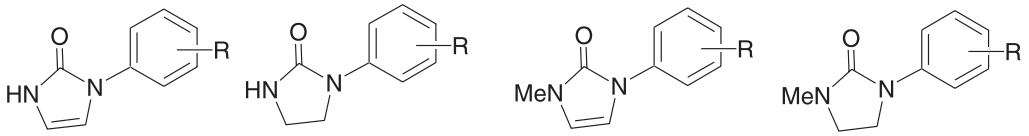


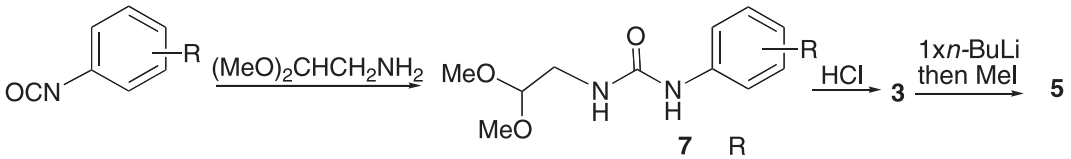
1 **2**



3 **4** **5** **6**

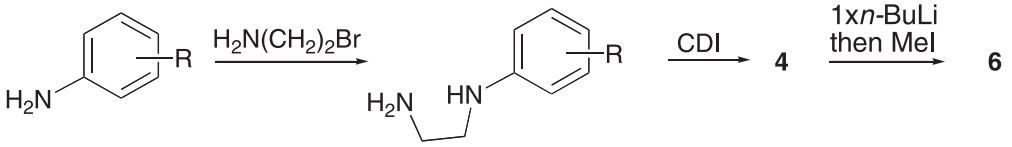
	R
a	H
b	2-OMe
c	3-OMe
d	4-OMe

Scheme 1.



	R
7	
a	H
b	2-OMe
c	3-OMe
d	4-OMe

Scheme 2.



	R
8	
a	H
b	2-OMe
c	3-OMe
d	4-OMe

methylphenyl)-4,4-dimethyloxazolidine can be made to compete with lithiation of the methyl group (16). The ortho-directing strength of a 1*H*-tetrazol-5-yl-substitutent was shown to be more than that of a methoxyl but less than that of diethylaminocarbonyl and this in turn less than that of a 2-(triphenylmethyl)-2*H*-tetrazol-5-yl substituent (17).

Syntheses of 1-arylimidazol-2(1*H*)-ones (3a–3d and 5a–5d) and 1-aryl-4,5-dihydro-imidazol-2(1*H*)-ones (4a–4d and 6a–6d)

The commercially available phenyl and 2-, 3-, and 4-methoxyphenyl isocyanates were each reacted with amino-acetaldehyde dimethyl acetal (18) and the resulting ureas **7** cyclised (19) by treatment with acid producing the imidazolones **3a**–**3d**. Reaction of each of these with 1 mol equiv. of *n*-butyllithium and then iodomethane cleanly gave their *N*-methyl derivatives, **5a**–**5d** (Scheme 1).

1-Aryl-4,5-dihydroimidazol-2(1*H*)-ones **4a**–**4d** were prepared following the method reported (20) for the synthesis of **4b**, namely cyclising *N*-aryl-1,2-diamines **8**, obtained by reaction of the aromatic amines with 2-bromoethanamine, using carbonyl diimidazole (CDI). The imidazolidinones **4a**–**4d** reacted smoothly with 1 mol equiv. of *n*-butyllithium and then iodomethane giving their *N*-methyl derivatives, **6a**–**6d** (Scheme 2).

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Lithiation of 1-arylimidazol-2(1*H*)-ones 3a–3d and 5a–5d

Treatment of the *N*-hydrogen imidazolones **3a**–**3d** with 2.5 mol equiv. of *n*-butyllithium and then excess iodomethane proceeded smoothly and gave rise to *N*- and benzene-ring-dimethylated products in good yields (Table 1). Noteworthy are: (*i*) the absence of products of nucleophilic addition to the unsaturated five-membered ring (cf. 1-arylpyrimidin-2(1*H*)-ones in ref. 1); (*ii*) the clean nature of the transformations, even in the substrate **3a** with no electron-withdrawing methoxyl on the benzene ring (→ **5e**); (*iii*) the regiochemistry of lithiation of the meta-methoxy substrate **3c** — between the methoxyl group and the imidazolone (→ **5h**) — the combined effect of the two groups producing this result; (*iv*) the formation from the ortho-methoxy substrate **3b** of a mixture of dimethylated products (**5f** and **5g**) from lithiation either ortho to the heterocycle (18%) or ortho to the methoxyl (25%); and (*v*) the regiochemistry of lithiation of the para-methoxy substrate **3d** in which there was no trace of lithiation ortho to the methoxyl group — the influence of the imidazolone being the greater (→ **5i**). Where there was ambiguity regarding the position of the introduced aromatic methyl, nOe experiments were employed. Thus, in **5g** the proximity of the methoxyl methyl and the ring methyl was established, and for **5i** there was no nOe on the methyl (δ 2.23) on irradiation of the methoxyl methyl (δ 3.83) and conversely, irradation at 2.23 had no effect on the methoxyl but did show an nOe to the imidazolone signal at δ 6.27. We interpret the trapping results as involving the double methylation of dilithio species **1**, the formation of which are favoured by the aromatic character of the five-membered ring in these.

Experiments with **3a**–**3d** again using 2.5 mol equiv. of *n*-butyllithium, but with phenyl isocyanate as the trapping electrophile, produced *N*- and *C*-disubstituted, biuret-anilide products **9b**–**9e** and **9h**, with exactly comparable regioselectivity, but only in moderate yields, and in some cases accompanied by minor amounts of the mono-*N*-substituted biuret (**9a**, **9f**, **9g**) (Table 1).

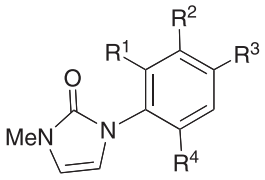
To determine whether an imidazolone that is not capable of *N*-deprotonation could act as an ortho-directing group, in partial analogy to the use of an *N*,*N*-dialkylamide as an ortho-directing group, we treated the *N*-methyl imidazolones **5a**–**5d** with *n*-BuLi and quenched with iodomethane. Here, there was a complete reversal of selectivity and a total preference for lithiation of the five-membered heterocycle when using approximately 1 equiv. of the strong base, though not very efficiently. Both 4- and 5-methylated products were formed — **5j/5k**, **5l/5m**, **5n/5o** — with the 4-methylated isomers predominating (Table 1). The regiochemistry of the methylation was established by nOe experiments — for the 3,4-dimethylimidazolones, e.g., **5k**, irradation of the *N*-methyl signal (δ 3.26) gave an effect with the *C*-methyl (δ 2.11), but not the remaining imidazolone ring proton (δ 6.33).

Even more intriguingly, when 2.5 mol equiv. of *n*-butyllithium were employed for the lithiation of **5a**–**5d**, dimethylated products were obtained in which one methyl had been introduced onto the benzene ring ortho to the imidazolone, presumably with its assistance, and the other at

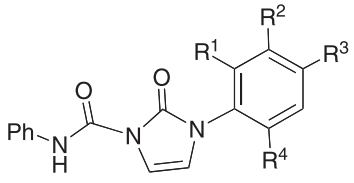
Table 1. Products and yields from lithations.

Substrate	*n*-BuLi (mol equiv.)	Electrophile	Product (% yield)	Product (% yield)
3a	2.5	MeI	**5e** (88)	
3b	2.5	MeI	**5f** (18)	**5g** (25)
3c	2.5	MeI	**5h** (60)	
3d	2.5	MeI	**5i** (96)	
4a	2.5	MeI	**6e** (34)	
4b	2.5	MeI	**6f** (28)	**6g** (37)
4c	2.5	MeI	**6h** (22)	
4d	2.5	MeI	**6i** (9)	**6j** (12)
3a	2.5	PhNCO	**9a** (3)	**9b** (86)
3b	2.5	PhNCO	**9c** (15)	**9d** (18)
3c	2.5	PhNCO	**9e** (36)	**9f** (21)
3d	2.5	PhNCO	**9g** (6.5)	**9h** (30)
5a	1.2	MeI	**5j** (12)	**5k** (46)
5b	1.2	MeI	**5l** (12)[a]	**5m** (36)[a]
5d	1.1	MeI	**5n** (49)	**5o** (16)
5a	2.5	MeI	**5p** (95)	
5b	2.5	MeI	**5q** (88)	
5c	2.5	MeI	**5r** (24)	
5d	2.5	MeI	**5s** (97)	

[a]Estimate from the ^{1}H NMR spectrum of the mixture.



5	R^1	R^2	R^3	R^4
e	Me	H	H	H
f	Me	H	H	OMe
g	OMe	Me	H	H
h	Me	OMe	H	H
i	Me	H	OMe	H



9	R^1	R^2	R^3	R^4
a	H	H	H	H
b	C(O)NHPh	H	H	H
c	C(O)NHPh	H	H	OMe
d	OMe	C(O)NHPh	H	H
e	C(O)NHPh	OMe	H	H
f	H	OMe	H	H
g	H	H	OMe	H
h	C(O)NHPh	H	OMe	H

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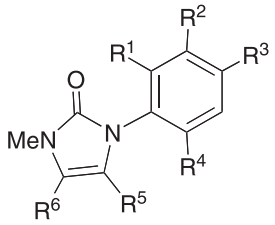
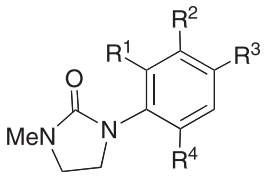


5	R^1	R^2	R^3	R^4	R^5	R^6
j	H	H	H	H	Me	H
k	H	H	H	H	H	Me
l	OMe	H	H	H	Me	H
m	OMe	H	H	H	H	Me
n	H	H	OMe	H	H	Me
o	Me	H	OMe	H	Me	H
p	Me	H	H	H	H	Me
q	OMe	H	H	Me	H	Me
r	Me	OMe	H	H	H	Me
s	Me	H	OMe	H	H	Me

C-4 of the imidazolone, with no C-5-methylation. Products **5p**, **5q**, and **5s** were formed very efficiently, but **5r** only in poor yield (Table 1). Again, nOe experiments involving irradiation of the *N*-methyl signals in the products **5p**–**5s** caused nOe enhancement of the *C*-methyl signal in each case, but had no effect on the imidazole C-5-proton signals.

The results described above in the lithiations of **5a**–**5d** were unexpected and a full understanding will require further experimentation. We offer the following explanation (Scheme 3) as a speculative rationalization for the observations. We suggest that initial lithiation of **5a**–**5d** takes place at C-4 of the imidazolone ring, giving **A** and that trapping of this species in the experiments using 1 mol equiv. of *n*-BuLi leads to the 3,4-dimethylated products **5k**, **5m**, and **5n**. We further speculate that **A** can undergo ring opening to generate an alkyne, rather as has been reported for lithiated isoxazoles (21) and oxazoles (22), generating **B**, which after conversion to the *C*-lithiated species **C** gives rise to the 3,5-dimethylated products **5j**, **5l**, and **5o** via alkyne *C* methylation then ring closure of **D**. In the experiments where 2.5 mol equiv. of the base were employed, benzene ring C lithiation of **B** using the second equivalent of base with ortho assistance, would give **E** and thence benzene-ring-methylated **F**, final closure of which would lead specifically



6	R^1	R^2	R^3	R^4
e	Me	H	H	H
f	Me	H	H	OMe
g	OMe	Me	H	H
h	Me	OMe	H	H
i	Me	H	H	OMe
j	H	Me	OMe	H

to the trimethylated 3,4-dimethylimidazolones **5p**–**5s** as shown.

Lithiation of 1-arylimidazolidin-2(1*H*)-ones (4a–4d) and attempted lithiation of 6a–6d

The use of 2.5 mol equiv. of *n*-butyllithium and then excess iodomethane gave rise to products **6e**–**6j** dimethylated on nitrogen and the benzene ring; when the *N*-hydrogen imidazolidinones **4a**–**4d** were examined (Table 1), however, these transformations were not as efficient as those involving the imidazolones **3a**–**3d**. Noteworthy are: (*i*) benzene ring lithiation ortho to the heterocycle (→ **6e**), even in the substrate **4a** with no electron-withdrawing methoxyl; (*ii*) the regiochemistry of lithiation of the meta-methoxy-substrate **4c** — between the methoxyl group and the imidazolidinone (→ **6h**); and (*iii*) the regiochemistry of lithiation of the ortho-**4b** and para-methoxy **4d** substrates — alternative lithiations ortho to either methoxyl or imidazolidinone groups being observed in both cases, giving **6f/6g** (ortho to the heterocycle 28% and ortho to the methoxyl 37%) and **6i/6j** (ortho to the heterocycle 9% and ortho to the methoxyl 12%), respectively.

The significantly more facile ortho lithiations observed with the *N*-arylimidazolones **3** as opposed to the *N*-arylimidazolidinones **4** seem unlikely to reside in their relative ease of *N*-deprotonation, even though in the former case, an aromatic alkoxide anion is generated. Rather, we suggest that subtle stereochemical factors, that influence the ease with which ortho assistance can be conveyed, are at play. We hope to be able to comment further on this aspect in future publications.

Attempted lithiation ortho to the *N*-methylimidazolidinone unit in substrates **6a**–**6d** failed.

Experimental

General

See ref. 1.

Typical procedure for synthesis of ureas (7)

N-*(2-Methoxyphenyl)*-N′-*(2,2-dimethoxyethyl)*urea *(7b)*

2-Methoxyphenyl isocyanate (4.77 g, 31.98 mmol) was added over a period of 5 min to aminoacetaldehyde dimethyl acetal (3.36 g, 31.98 mmol, 1 equiv.) while cooling in an ice bath. The reaction was allowed to warm up to rt for 1 h during which time a yellow crystalline mass was formed. The solid was washed with petroleum ether, dissolved in CH_2Cl_2, and the solution evaporated. Column SiO_2 chromatography (50% EtOAc in hexane) gave *N*-(2-methoxyphenyl)-*N′*-(2,2-dimethoxyethyl)urea **7b** as white crystals (6.98 g, 85%), mp 92–94 °C. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.42 (2H, m, CH_2CH), 3.48 (6H, s, 2 × OCH_3), 3.88 (3H, s, OCH_3), 4.47 (1H, t, J = 5.2, CH_2CH), 5.05 (1H, bt, J = 5.5, NH), 6.86–7.06 (4H, m, Ar-H), 8.05 (1H, m, Ar-NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 41.8, 54.4, 55.5, 103.4, 110.0, 119.5, 121.0, 122.3, 128.5, 142.1, 155.6. *m*/*z* (CI): 255 (MH^+, 100%), 223 (95), 75 (30). Anal. calcd. for $C_{12}H_{18}N_2O_4$ (M): 254.126 65; found (M^+): 254.126 9.

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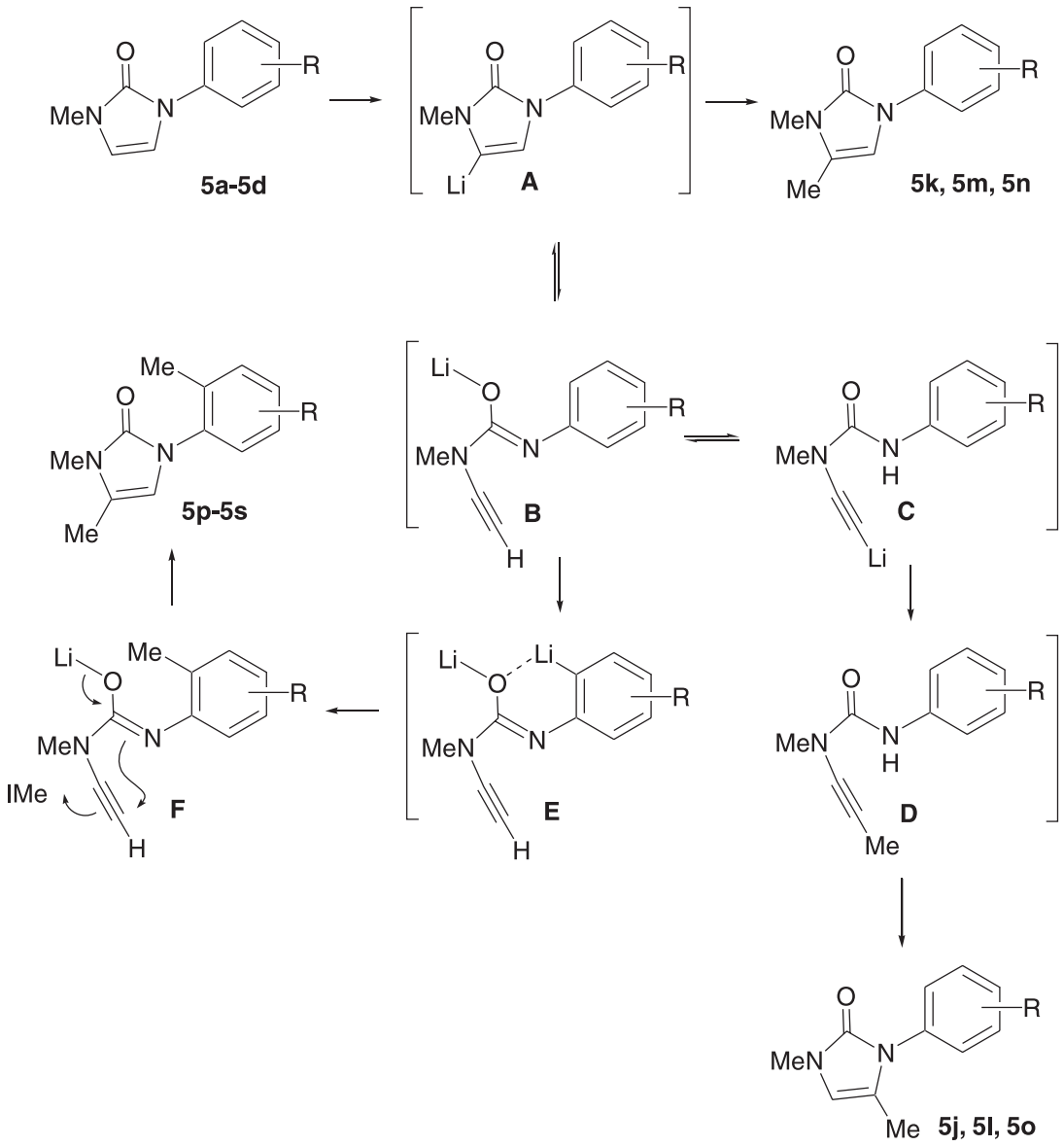
Scheme 3.



N-*(Phenyl)*-N′-*(2,2-dimethoxyethyl)urea (7a)*

N-(Phenyl)-*N′*-(2,2-dimethoxyethyl)urea (**7a**) was prepared as above from phenyl isocyanate (5 g, 41.9 mmol) and aminoacetaldehyde dimethyl acetal (4.5 mL, 41.9 mmol, 1 equiv.) giving **7a** as a white crystalline solid (9.53 g, 89%), mp 89–91 °C, lit. value (18) mp 86–89 °C. IR ν_{max} (film, cm^{-1}): 755, 1070, 1130, 1238, 1311, 1441, 1499, 1555, 1597, 1654, 3340. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.41 (6H, s, OCH_3), 3.41 (2H, m, CH_2CH), 4.43 (1H, t, *J* = 5.1, CH_2CH), 5.82 (1H, t, *J* = 5.8, NH), 7.03 (1H, m, ArH), 7.28 (4H, m, ArH), 7.58 (1H, s, NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 41.7, 54.5, 103.5, 120.1, 123.1, 128.9, 138.8, 156.3. *m/z* (CI): 225 (MH^+, 74%), 193 (100), 75 (92). Anal. calcd. for $C_{11}H_{16}N_2O_3$ (M): 224.116 1; found (M^+): 224.115 9.

N-*(3-Methoxyphenyl)*-N′-*(2,2-dimethoxyethyl)urea (7c)*

N-(3-Methoxyphenyl)-*N′*-(2,2-dimethoxyethyl)urea (**7c**) was prepared as above from 3-methoxyphenyl isocyanate (1 g, 6.7 mmol) and aminoacetaldehyde dimethyl acetal (0.7 g, 6.7 mmol, 1 equiv.) giving **7c** as a white crystalline solid (1.615 g, 95%) pure enough for its subsequent use. An analytical sample was recrystallized from EtOAc–hexane, mp 102 °C. IR ν_{max} (film, cm^{-1}): 1556, 1606, 1653, 2875, 2958. ^{1}H NMR (300 MHz, d_6-DMSO) δ: 3.44 (2H, m, CH_2CH), 3.44 (6H, s, 2 × OCH_3), 3.72 (3H, s, OCH_3), 4.39 (1H, t, *J* = 5.1, CH_2CH), 6.49 (1H, apparent dd, *J* = 8.2, 2.9, ArH), 6.84 (1H, apparent dd, *J* = 8.2, 2.9, ArH), 7.12 (1H, bs, ArH), 7.14 (1H, bs, NH), 7.15 (1H, t, *J* = 8.2, ArH), 8.6 (1H, s, NH). ^{13}C NMR (75 MHz, d_6-DMSO) (DEPT) δ: 41.0 (d), 53.7 (q), 55.2 (q), 102.9 (d), 103.7 (d), 106.9 (d), 110.3 (d), 129.7 (d), 141.9 (s), 155.4 (s), 160.0 (s). *m/z* (CI): 255 (MH^+, 7%), 208 (25), 191 (100). Anal. calcd. for $C_{12}H_{18}N_2O_4$ (%): C 56.68, H 7.13, N 11.02; found (%): C 57.07, H 7.00, N 10.99. Anal. calcd. for $C_{12}H_{18}N_2O_4$ (M): 254.1267; found (M^+): 254.1272.

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N-*(4-Methoxyphenyl)*-N′-*(2,2-dimethoxyethyl)urea (7d)

N-(4-Methoxyphenyl)-*N′*-(2,2-dimethoxyethyl)urea (**7d**) was prepared from 4-methoxyphenyl isocyanate (5 g, 33.5 mmol) and aminoacetaldehyde dimethyl acetal (3.61 mL, 33.5 mmol, 1 equiv.) giving **7d** as a white crystalline solid (7.9 g, 92%), mp 112–114 °C. IR ν_{max} (film, cm^{-1}): 1240, 1509, 1551, 1560, 1638, 1654, 3400. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.40 (6H, s, OCH_3), 3.40 (2H, d, *J* = 5.0, C*H*$_2$CH), 3.78 (3H, s, $ArOCH_3$), 4.41 (1H, t, *J* = 5.0, CH_2C*H*), 6.82 (1H, d, *J* = 6.9, ArH), 7.19 (2H, d, *J* = 6.9, ArH), 7.21 (1H, s, NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 41.7, 54.4, 55.4, 103.4, 114.3, 123.2, 131.4, 156.2, 156.7. *m/z* (CI): 255 (MH^+, 100%), 223 (90), 75 (100). Anal. calcd. for $C_{12}H_{18}N_2O_4$ (%): C 56.68, H 7.13, N 11.02; found (%): C 57.07, H 7.00, N 10.99. Anal. calcd. for $C_{12}H_{18}N_2O_4$ (M): 254.126 7; found (M^+): 254.126 4.

Typical procedure for the synthesis of imidazolones (3)

1-(2-Methoxyphenyl)imidazol-2(1H)-one (3b)

N-(2-Methoxyphenyl)-*N′*-(2,2-dimethoxyethyl)urea (**7b**) (1.12 g, 4.4 mmol) was dissolved in aq. 2 mol L^{-1} HCl (10 mL). The solution was stirred at rt for 20 h. The resulting clear solution was made basic with aq. 2 mol L^{-1} NaOH, extracted with CH_2Cl_2, then the extract was dried over $MgSO_4$ and evaporated, yielding 1-(2-methoxyphenyl)imidazol-2(1*H*)-one **3b** as a white crystalline solid (0.92 g, 82%), mp 160–162 °C. IR ν_{max} (film, cm^{-1}): 764, 1024, 1244, 1283, 1431, 1465, 1510, 1684, 2934. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.88 (s, 3H, OCH_3), 6.39 (1H, apparent t, *J* = 2.6, ImH), 6.44 (1H, apparent t, *J* = 2.6, ImH), 7.07 (2H, m, ArH), 7.37 (1H, m, ArH), 7.49 (1H, dd, *J* = 7.6, 1.6, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 55.7, 108.5, 112.2, 113.5, 120.8, 125.0, 128.2, 129.0, 154.2, 154.4. *m/z* (CI): 191 (MH^+, 100%). Anal. calcd. for $C_{10}H_{10}N_2O_2$ (%): C 63.15, H 5.30, N 14.73; found (%): C 63.23, H 5.40, N 14.55. Anal. calcd. for $C_{10}H_{10}N_2O_2$ (M): 190.074 2; found (M^+): 190.074 5.

1-Phenylimidazol-2(1H)-one (3a)

1-Phenylimidazol-2(1*H*)-one (**3a**) was prepared as above from *N*-(phenyl)-*N′*-(2,2-dimethoxyethyl)urea **7a** (7 g, 31.2 mmol) in aq. 2.5 mol L^{-1} HCl (60 mL) giving **3a** as a white crystalline solid (3.27 g, 65%), mp 127 °C, lit. value (19) mp 123–126 °C. IR ν_{max} (film, cm^{-1}): 756, 1424, 1503, 1598, 1667, 3061, 3156. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 6.45 (1H, apparent t, *J* = 2.5, ImH), 6.57 (1H, apparent t, *J* = 2.5, ImH), 7.31 (1H, m, ArH), 7.48 (2H, m, ArH), 7.61 (2H, m, ArH), 11.1 (1H, bs, NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 109.6, 111.0, 122.3, 126.1, 129.2, 136.9, 153.8. *m/z* (CI): 178 (MNH_4^+, 100%), 161 (MH^+, 99). Anal. calcd. for $C_9H_8N_2O$: (M): 160.063 7; found (M^+): 160.063 8.

1-(3-Methoxyphenyl)imidazol-2(1H)-one (3c)

1-(3-Methoxyphenyl)imidazol-2(1*H*)-one (**3c**) was prepared as above from *N*-(3-methoxyphenyl)-*N′*-(2,2-dimethoxyethyl)urea **7c** (1.2 g, 4.7 mmol) in aq. 2.5 mol L^{-1} HCl (20 mL) giving **3c** as a white crystalline solid (0.87 g, 97%), pure enough for its subsequent use, mp 136 °C. IR ν_{max} (film, cm^{-1}): 1230, 1497, 1687. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.88 (s, 3H, OCH_3), 6.50 (1H, d, *J* = 2.5, ImH), 6.62 (1H, d, *J* = 2.5, ImH), 6.86 (1H, dd, *J* = 8.1, 2.5, ArH), 7.17 (1H, apparent d, *J* = 8.1, ArH), 7.23 (1H, bs, ArH), 7.38 (1H, t, *J* = 8.1, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 55.4, 108.3, 109.6, 111.0, 111.8, 114.4, 129.9, 138.0, 153.8, 160.2. *m/z* (CI): 208 (MNH_4^+, 30%), 191 (MH^+, 100). Anal. calcd. for $C_{10}H_{10}N_2O_2$ (M): 190.074 2; found (M^+): 190.073 8.

1-(4-Methoxyphenyl)imidazol-2(1H)-one (3d)

1-(4-Methoxyphenyl)imidazol-2(1*H*)-one (**3d**) was prepared as above from *N*-(4-methoxyphenyl)-*N′*-(2,2-dimethoxyethyl)urea **7d** (7 g, 27.5 mmol) in aq. 2.5 mol L^{-1} HCl (60 mL) giving **3d** as a white crystalline solid (4.69 g, 89%), mp 158 °C. IR ν_{max} (film, cm^{-1}): 1234, 1247, 1512, 1667. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.86 (s, 3H, OCH_3), 6.42 (1H, apparent t, *J* = 2.5, ImH), 6.49 (1H, apparent t, *J* = 2.5, ImH), 7.00 (2H, d, *J* = 6.9, ArH), 7.48 (2H, d, *J* = 6.9, ArH), 11.1 (1H, s, NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 55.5, 109.2, 111.5, 114.4, 124.3, 129.9, 157.9. *m/z* (CI): 208 (MNH_4^+, 2%), 191 (MH^+,100). Anal. calcd. for $C_{10}H_{10}N_2O_2$ (%): C 63.15, H 5.30, N 14.73; found (%): C 63.20, H 5.38, N 14.79. Anal. calcd. for $C_{10}H_{10}N_2O_2$ (M): 190.074 2; found (M^+): 190.073 9.

Typical procedure for synthesis of 1-aryl-3-methylimidazolones (5)

1-(2-Methoxyphenyl)-3-methylimidazol-2(1H)-one (5b)

A solution of 1-(2-methoxyphenyl)imidazol-2(1*H*)-one **3b** (0.26 g, 1.37 mmol) in anhyd. THF at –78 °C was treated with *n*-BuLi (1.6 mol L^{-1}, 0.89 mL, 1.1 equiv.) over 30 min under N_2. The solution was warmed up to 0 °C for 2 h and then cooled to –78 °C for the addition of iodomethane (0.09 mL, 1.43 mmol, 1.1 equiv.). The reaction mixture was allowed to warm up to rt and after 20 h the reaction was quenched with satd. aq. NH_4Cl and evaporated to remove the THF. The organic residue was dissolved in CH_2Cl_2, the solution washed with brine, dried and evaporated to give 1-(2-methoxyphenyl)-3-methylimidazol-2(1*H*)-one **5b** as a clear yellow oil (0.25 g, 94%). IR ν_{max} (film, cm^{-1}): 1045, 1224, 1270, 1405, 1461, 1497, 1605, 1687. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.35 (3H, s, NCH_3), 3.87 (3H, s, OCH_3), 6.31 (1H, d, *J* = 2.9, ImH), 6.47 (1H, d, *J* = 2.9, ImH), 7.04 (2H, apparent t, *J* = 8.0, ArH), 7.34 (1H, m, ArH), 7.47 (1H, dd, *J* = 8.0, 1.6, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 30.5, 55.7, 107.2, 110.1, 111.3, 112.1, 112.2, 120.8, 127.9, 128.6, 154.0. *m/z* (CI): 222 (MNH_4^+, 22%), 205 (MH^+, 100). $C_{11}H_{12}N_2O_2$ (M): 204.089 9; found (M^+): 204.090 0.

3-Methyl-1-phenylimidazol-2(1H)-one (5a)

3-Methyl-1-phenylimidazol-2(1*H*)-one (**5a**) was prepared as above from 1-phenylimidazol-2(1*H*)-one **3a** (0.5 g, 3.12 mmol) and *n*-BuLi (1.6 mol L^{-1}, 2.15 mL, 1.1 equiv.) then iodomethane (0.29 mL, 4.7 mmol, 1.5 equiv.) giving **5a** as a white solid (0.52 g, 96%). An analytical sample was prepared by column SiO_2 chromatography (50% EtOAc in hexane), mp 119–121 °C, lit. value (23) mp 119 °C. IR ν_{max} (film, cm^{-1}): 766, 1266, 1344, 1402, 1452, 1459, 1507, 1600, 1672, 3060, 3135. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.35 (3H, s, NCH_3), 6.35 (1H, d, *J* = 3.0, ImH), 6.59 (1H, d, *J* = 3.0, ImH), 7.26 (1H, m, ArH), 7.44 (2H, apparent t, *J* = 8.0 ArH), 7.63 (2H, m, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ:

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30.4, 109.1, 112.6, 111.06, 121.5, 125.6, 129.1, 137.3, 155.4. *m/z* (CI): 192 (MNH_4^+, 32%), 175 (MH^+, 100).

1-(3-Methoxyphenyl)-3-methylimidazol-2(1H)-one (5c)

1-(3-Methoxyphenyl)-3-methylimidazol-2(1*H*)-one (**5c**) was prepared as above from 1-(3-methoxyphenyl)imidazol-2(1*H*)-one **3c** (0.8 g, 4.2 mmol) and *n*-BuLi (1.6 mol L^{-1}, 2.9 mL, 1.1 equiv.) then iodomethane (0.29 mL, 4.6 mmol, 1.1 equiv.) giving **5c** as a clear yellow oil (0.73 g, 86%). ^1H NMR (300MHz, $CDCl_3$) δ: 3.35 (3H, s, NCH_3), 3.87 (3H, s, OCH_3), 6.35 (1H, d, *J* = 3.0, ImH_a), 6.59 (1H, d, *J* = 3.0, ImH_b), 6.81 (1H, dd, *J* = 8.1, 3.0, ArH), 7.15 (1H, dd, *J* = 8.1, 3.0, ArH), 7.29 (1H, s, ArH), 7.34 (1H, t, *J* = 8.1, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 30.4, 55.3, 107.2, 109.1, 111.6, 111.7, 112.6, 113.3, 129.7, 138.5, 160.2. *m/z* (CI): 222 (MNH_4^+, 22%), 205 (MH^+, 100). Anal. calcd. for $C_{11}H_{12}N_2O_2$ (M): 204.089 9; found (M^+): 204.090 5.

1-(4-Methoxyphenyl)-3-methylimidazol-2(1H)-one (5d)

1-(4-Methoxyphenyl)-3-methylimidazol-2(1*H*)-one (**5d**) was prepared as above from 1-(4-methoxyphenyl)imidazol-2(1*H*)-one **3d** (0.5 g, 2.6 mmol) and *n*-BuLi (1.6 mol L^{-1}, 1.8 mL, 1.1 equiv.) then iodomethane (0.24 mL, 3.9 mmol, 1.5 equiv.) giving **5d** as a white solid (0.516 g, 96%), mp 116–118 °C, lit. value (23) mp 114 °C. IR ν_{max} (film, cm^{-1}): 1248, 1458, 1514, 1678, 2360. ^1H NMR (300 MHz, $CDCl_3$) δ: 3.32 (3H, s, NCH_3), 3.83 (3H, s, OCH_3), 6.31 (1H, d, *J* = 2.9, ImH), 6.50 (1H, d, *J* = 2.9, ImH), 6.95 (2H, d, *J* = 6.9, ArH), 7.48 (2H, d, *J* = 6.9, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 30.4, 55.4, 109.7, 111.8, 112.2, 114.2, 123.4, 130.5, 157.5. *m/z* (CI): 222 (MNH_4^+, 22%), 205 (MH^+, 100). Anal. calcd. for $C_{11}H_{12}N_2O_2$ (M): 204.089 9; found (M^+): 204.089 7.

Typical procedure for the synthesis of aryldiamines (8)

N-*(2-Methoxyphenyl)-1,2-diaminoethane (8b)*

A mixture of freshly distilled *o*-anisidine (19.7 g, 160 mmol) and 2-bromoethylamine hydrobromide (19.7 g, 160 mmol, 1 equiv.) in dry toluene (40 mL) was heated at reflux temperature for 18 h, and then cooled. A solution of 50% aq. NaOH and CH_2Cl_2 were added and the layers separated. The aqueous layer was saturated with NaCl and extracted with CH_2Cl_2. The combined organic layers were dried over $MgSO_4$, filtered and evaporated to dryness. Dry flash column SiO_2 chromatography (40%–100% of CH_2Cl_2 in hexane) yielded *N*-(2-methoxyphenyl)-1,2-diaminoethane **8b** (9.99 g, 75%) as a light brown low oil. ^1H NMR (24) (300 MHz, $CDCl_3$) δ: 1.98 (2H, bs, NH_2), 3.02 (2H, t, *J* = 5.6, CH_2), 3.24 (2H, t, *J* = 5.6, CH_2), 3.5 (1H, bs, NH), 3.9 (3H, s, $ArOCH_3$), 6.70 (2H, m, ArH), 6.80 (1H, m, ArH), 6.90 (1H, m, Ar). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 41.3, 46.5, 55.4, 109.7, 110.2, 116.5, 121.4, 138.0, 146.8. *m/z* (CI): 167 (MH^+, 100%). Anal. calcd. for $C_8H_{11}N_2O$ (M – Me): 151.082 1; found: 151.063 7.

N-*Phenyl-1,2-diaminoethane (8a)*

N-Phenyl-1,2-diaminoethane (**8a**) was prepared as above from aniline (5 g, 53 mmol) and 2-bromoethylamine hydrobromide (5.5 g, 26 mmol, 0.5 equiv.) giving **8a** (1.5 g, 42%) as a clear oil (23). IR ν_{max} (film, cm^{-1}): 749, 1320, 1506, 1602, 2862, 2937, 3024, 3048, 3343. ^1H NMR (300 MHz, d_6-DMSO) δ: 2.85 (2H, t, *J* = 6.3, CH_2), 3.16 (2H, m, CH_2), 5.07 (2H, bs, NH_2), 5.75 (1H, bs, NH), 6.57 (3H, m, ArH), 7.10 (2H, m, ArH). ^{13}C NMR (75 MHz, d_6-DMSO) δ: 39.7, 44.3, 112.8, 116.6, 129.7, 149.4. *m/z* (CI): 137 (MH^+, 100%).

N-*(3-Methoxyphenyl)-1,2-diaminoethane (8c)*

N-(3-Methoxyphenyl)-1,2-diaminoethane (**8c**) was prepared as above from *m*-anisidine (20 g, 0.16 mmol) and 2-bromoethylamine hydrobromide (16.6 g, 0.8 mol, 0.5 equiv.) giving **8c** (9.78 g, 73%) as a brown semi-solid, lit. value (24) mp 45 to 46 °C. ^1H NMR (300 MHz, $CDCl_3$) δ: 1.42 (2H, bs, NH_2), 2.98 (2H, m, CH_2), 3.17 (2H, m, CH_2), 3.80 (3H, s, OCH_3), 6.20–6.35 (3H, m, ArH), 7.12 (1H, t, *J* = 8.1, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 41.1, 46.4, 54.9, 98.8, 102.4, 106.0, 129.8. *m/z* (CI): 167 (MH^+, 100%), 136 (20).

N-*(4-Methoxyphenyl)-1,2-diaminoethane (8d)*

N-(4-Methoxyphenyl)-1,2-diaminoethane (**8d**) was prepared as above from *p*-anisidine (5 g, 40 mmol) and 2-bromoethylamine hydrobromide (4.15 g, 20 mmol, 0.5 equiv.) giving **8d** (1.35 g, 40%) as a brown solid, mp 60–62 °C, lit. value (25) mp 64 °C. IR ν_{max} (film, cm^{-1}): 823, 1034, 1236, 1512, 1668, 2932. ^1H NMR (300 MHz, CD_3OD) δ: 2.78 (2H, t, *J* = 6.1, CH_2), 3.07 (2H, t, *J* = 6.1, CH_2), 3.26 (1H, bs, NH), 4.83 (1H, bs, NH_2), 6.60 (2H, d, *J* = 9.0, ArH), 6.81 (2H, d, *J* = 9.0, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 41.6, 47.8, 56.1, 114.6, 115.2, 126.0, 142.9. *m/z* (CI): 167 (M^+, 100%), 136 (20), 124 (65).

Typical procedure for the synthesis of *N*-arylimidazolidinones (4)

4,5-Dihydro-1-(2-methoxyphenyl)imidazol-2(1H)-one (4b)

To a solution of *N*-(2-methoxyphenyl)-1,2-diaminoethane **8b** (9.97 g, 0.06 mol) in anhyd. THF (50 mL), 1,1-carbonyldiimidazole (18.44 g, 0.145 mol, 2.4 equiv.) was added under N_2. The solution was refluxed for 21 h and then evaporated to dryness to remove the THF. The yellow residue was taken up with EtOAc, the solution washed with brine, dried over $MgSO_4$ and evaporated. Column SiO_2 chromatography (25% of EtOAc in hexane) yielded 4,5-dihydro-1-(2-methoxyphenyl)imidazol-2(1*H*)-one **4b** as a white crystalline solid (2.77 g, 25%), mp 150–152 °C, lit. value (26) mp 151–153 °C. ^1H NMR (300 MHz, $CDCl_3$) δ: 3.60 (2H, t, *J* = 8.2, ImH), 3.85 (2H, t, *J* = 8.2, ImH), 3.90 (3H, s, OCH_3), 5.18 (1H, bs, NH), 6.99 (2H, m, ArH), 7.26 (1H, m, ArH), 7.39 (1H, dd, *J* = 7.7, 1.6, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 38.7, 47.3, 55.5, 111.9, 120.9, 127.7, 127.8, 128.6, 155.2, 162.0. *m/z* (CI): 193 (MH^+, 100%). Anal. calcd. for $C_{10}H_{12}N_2O_2$ (M): 192.089 9; found (M^+): 192.090 0.

4,5-Dihydro-1-phenylimidazol-2(1H)-one (4a)

4,5-Dihydro-1-phenylimidazol-2(1*H*)-one (**4a**) was prepared as above from *N*-phenyl-1,2-diaminoethane **8a** (1.5 g, 11 mmol) and 1,1-carbonyldiimidazole (7.2 g, 47 mmol, 4.3 equiv.) giving **4a** as a white crystalline solid (1.35 g, 76%), mp 159 °C, lit. value (27) mp 162 to 163 °C. IR ν_{max} (film, cm^{-1}): 748, 1150, 1484, 1680, 2906, 3424. ^1H NMR (300 MHz, $CDCl_3$) δ: 3.41 (2H, t, *J* = 7.9, ImH), 3.85 (2H, apparent t, *J* = 7.9, ImH), 6.94 (1H, bs, NH), 7.06 (1H, apparent t, *J* = 8.6, ArH), 7.35 (2H, apparent t, *J* = 8.6, ArH),

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7.56 (2H, apparent d, J = 8.6, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 42.0, 49.9, 122.4, 126.9, 134.0.

*4,5-Dihydro-1-(3-methoxyphenyl)imidazol-2(1*H*)-one (4c)*

4,5-Dihydro-1-(3-methoxyphenyl)imidazol-2(1*H*)-one (**4c**) was prepared as above from *N*-(3-methoxyphenyl)-1,2-diaminoethane **8c** (6 g, 0.036 mol) and 1,1-carbonyldiimidazole (25 g, 0.18 mol, 5.2 equiv.) giving **4c** as a white crystalline solid (4.35 g, 63%), mp 123 °C, lit. (20). IR ν_{max} (film, cm^{-1}): 662, 1259, 1411, 1482, 1601, 1705, 2923, 3257. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.60 (2H, apparent t, J = 7.8, ImH), 3.80 (s, 3H, OCH_3), 3.98 (2H, apparent t, J = 7.8, ImH), 6.67 (1H, dd, J = 8.2, 2.5, ArH), 7.09 (1H, dd, J = 8.2, 2.06, ArH), 7.26–7.32 (2H, m, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 41.3, 42.2, 55.3, 118.4, 129.5, 129.8, 138.4, 148.5, 151.09, 160.1. *m*/*z* (CI): 210 (MNH_4^+, 25%), 193 (100). Anal. calcd. for $C_{10}H_{12}N_2O_2$ (M): 192.089 9; found (M^+): 192.089 4.

*4,5-Dihydro-1-(4-methoxyphenyl)imidazol-2(1*H*)-one (4d)*

4,5-Dihydro-1-(4-methoxyphenyl)imidazol-2(1*H*)-one (**4d**) was prepared as above from *N*-(4-methoxyphenyl)-1,2-diaminoethane **8d** (1 g, 6 mmol) and 1,1′-carbonyldiimidazole (3.9 g, 52 mmol, 3.9 equiv.) giving **4d** as a white crystalline solid (0.45 g, 44%), mp 205–207 °C, lit. value (28) mp 211 °C. IR ν_{max} (film, cm^{-1}): 830, 1034, 1251, 1519, 1679, 3476, 3583. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.90 (3H, s, OCH_3), 3.97 (2H, t, J = 7.9, ImH), 4.17 (2H, t, J = 7.9, ImH), 7.01 (2H, d, J = 7.8, ArH), 7.41 (2H, d, J = 7.8, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 37.9, 46.2, 55.8, 114.3, 120.3, 141.6, 142.2, 158.7. *m*/*z* (CI): 210 (MNH_4^+, 10%), 193 (MH^+, 100).

Typical procedure for the synthesis of 1-aryl-3-methylimidazolidinones (6)

*4,5-Dihydro-1-(2-methoxyphenyl)-3-methylimidazol-2(1*H*)-one (6b)*

A solution of 4,5-dihydro-1-(2-methoxyphenyl)imidazol-2(1*H*)-one **4b** (0.250 g, 1.3 mmol) in anhyd. THF was treated with *n*-BuLi (1.6 mol L^{-1}, 0.9 mL, 1.1 equiv.) at –78 °C over 30 min under N_2. The solution was warmed then maintained at 0 °C for 2 h and cooled down to –78 °C again for the addition of iodomethane (0.09 mL, 1.43 mmol, 1.1 equiv.). The reaction mixture was warmed up to rt and after 20 h quenched with satd. aq. NH_4Cl and evaporated to remove the THF. The colourless residue was dissolved with CH_2Cl_2, the solution washed with brine, dried over $MgSO_4$ and evaporated to yield 4,5-dihydro-1-(2-methoxyphenyl)-3-methylimidazol-2(1*H*)-one **6b** (0.26 g, 95%) as a dark yellow oil. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.92 (3H, s, NCH_3), 3.48 (2H, t, J = 7.7, ImH), 3.78 (2H, t, J = 7.7, ImH), 3.88 (3H, s, OCH_3), 6.92 (2H, m, ArH), 7.25 (1H, m, ArH), 7.38 (1H, dd, J = 7.8, 1.6, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 31.5, 44.6, 45.4, 55.5, 111.8, 120.8, 127.4, 128.4, 129.3, 155.1, 160.0. *m*/*z* (CI): 207 (MH^+, 100%). Anal. calcd. for $C_{11}H_{14}N_2O_2$ (M): 206.105 5; found (M^+): 206.105 5.

*4,5-Dihydro-3-methyl-1-phenylimidazol-2(1*H*)-one (6a)*

4,5-Dihydro-3-methyl-1-phenylimidazol-2(1*H*)-one (**6a**) was prepared as above from 4,5-dihydro-1-phenylimidazol-2(1*H*)-one **4a** (0.162 mg, 1 mmol), *n*-BuLi (1.6 mol L^{-1}, 0.68 mL, 1.1 equiv.) then iodomethane (0.06 mL, 1.1 mmol, 1.1 equiv.) giving **6a** as a white crystalline solid (126 mg, 71%). An analytical sample was prepared by column SiO_2 chromatography (50% of EtOAc in hexane), mp 99 °C, lit. value (29) mp 110 to 111 °C. IR ν_{max} (film, cm^{-1}): 742, 899, 1275, 1387, 1404, 1439, 1476, 1504, 1598, 1702, 2826, 2887, 2917, 2952. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.93 (3H, s, NCH_3), 3.48 (2H, t, J = 8.3, ImH), 3.80 (2H, t, J = 8.3, ImH), 7.05 (1H, dt, J = 7.3, 1.0, ArH), 7.32 (1H, m, ArH), 7.60 (1H, m, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 31.4, 42.5, 44.3, 117.4, 122.4, 129.0, 140.9, 158.4. *m*/*z* (CI): 177 (MH^+, 100%), 105 (2).

*4,5-Dihydro-1-(3-methoxyphenyl)-3-methylimidazol-2(1*H*)-one (6c)*

4,5-Dihydro-1-(3-methoxyphenyl)-3-methylimidazol-2(1*H*)-one (**6c**) was prepared as above from 4,5-dihydro-1-(3-methoxyphenyl)imidazol-2(1*H*)-one **4c** (200 mg, 1.04 mmol, 1 equiv.) and *n*-BuLi (1.6 mol L^{-1}, 0.875 mL) then iodomethane (0.60 mL, 1.04 mmol, 1 equiv.) giving **6c** (200 mg, 93%) as white solid, mp 95 °C, lit. value (29) mp 97–99 °C. IR ν_{max} (film, cm^{-1}): 1221, 1452, 1500, 1601, 1703. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.93 (3H, s, NCH_3), 3.50 (2H, apparent t, J = 7.9, ImH), 3.83 (2H, m, ImH), 3.85 (3H, s, OCH_3), 6.63 (1H, dd, J = 8.2, 2.2, ArH), 7.04 (1H, dd, J = 8.2, 2.2, ArH), 7.25 (1H, t, J = 8.2, ArH), 7.41 (1H, m, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 31.1, 42.3, 43.9, 55.2, 103.1, 108.1, 109.1, 109.7, 129.3, 141.9, 159.9. *m*/*z* (CI): 207 (M^+, 100). Anal. calcd. for. $C_{10}H_{12}N_2O_2$ (M): 206.105 5; found (M^+): 206.105 5.

*4,5-Dihydro-1-(4-methoxyphenyl)-3-methylimidazol-2(1*H*)-one (6d)*

4,5-Dihydro-1-(4-methoxyphenyl)-3-methylimidazol-2(1*H*)-one (**6d**) was prepared as above from 4,5-dihydro-1-(4-methoxyphenyl)imidazol-2(1*H*)-one **4d** (0.25 g, 1.3 mmol) and *n*-BuLi (1.6 mol L^{-1}, 0.89 mL, 1.1 equiv.) then iodomethane (0.085 mL, 1.43 mmol, 1.1 equiv.) giving **6d** (180 mg, 68%) as a solid, mp 56 to 57 °C. IR ν_{max} (film, cm^{-1}): 828, 1038, 1252, 1686, 2948. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.83 (3H, s, NCH_3), 3.39 (2H, apparent t, J = 7.6, ImH), 3.71 (2H, apparent t, J = 7.6, ImH), 3.73 (3H, s, OCH_3), 6.82 (2H, d, J = 8.9, ArH), 7.39 (2H, d, J = 8.9, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 31.6, 43.1, 44.6, 55.8, 114.4, 119.5, 134.4, 146.2, 155.6. *m*/*z* (CI): 207 (MH^+, 100). Anal. calcd. for. $C_{10}H_{12}N_2O_2$ (M): 206.105 5; found (M^+): 206.105 8.

Typical procedure for reaction of imidazolones (3a–3d) and imidazolidinones (4a–4d) with 2.5 equiv. of *n*-BuLi then trapping with MeI

*1-(2-Methoxy-3-methylphenyl)-3-methylimidazol-2(1*H*)-one (5g) and 1-(2-methoxy-6-methylphenyl)-3-methylimidazol-2(1*H*)-one (5f)*

A solution of 1-(2-methoxyphenyl)imidazol-2(1*H*)-one **3b** (0.26 g, 1.3 mmol) in anhyd. THF was treated with *n*-BuLi (1.6 mol L^{-1}, 2 mL, 2.5 equiv.) at –78 °C over 30 min under N_2. The solution was warmed up to then maintained at 0 °C for 2 h and cooled down to –78 °C again for the addition of iodomethane (0.2 mL, 3.25 mmol, 2.5 equiv.). The reaction

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mixture was allowed to warm up to rt and after 20 h quenched with satd. aq. NH_4Cl, and evaporated to remove the THF. The organic residue was taken up with CH_2Cl_2, the solution washed with brine, dried and evaporated. Column SiO_2 chromatography (50% of EtOAc in petroleum ether) yielded firstly 1-(2-methoxy-3-methylphenyl)-3-methylimidazol-2(1*H*)-one **5g** (70 mg, 25%), secondly 1-(2-methoxy-6-methylphenyl)-3-methylimidazol-2(1*H*)-one **5f** (50 mg, 18%) as yellow oils. Spectroscopic data for **5g**: ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.25 (3H, s, $ArCH_3$), 3.27 (3H, s, NCH_3), 3.57 (3H, s,OCH_3), 6.24 (2H, d, *J* = 3.0, ImH), 6.45 (1H, d, *J* = 3.0, ImH), 7.07 (1H, d, *J* = 8.2, ArH), 7.15 (1H, d, *J* = 8.2, ArH), 7.35 (1H, t, *J* = 8.2, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 15.9, 30.5, 55.7, 111.4, 111.8, 111.9, 124.0, 125.4, 128.7, 129.6, 130.2, 156.0. *m*/*z* (CI): 219 (MH^+, 100%). Anal. calcd. for. $C_{12}H_{14}N_2O_2$ (M): 218.105 5; found (M^+): 218.105 6. Spectroscopic data for **5g**: ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.22 (3H, s, $ArCH_3$), 3.37 (3H, s, NCH_3), 3.82 (3H, s, OCH_3), 6.23 (2H, d, *J* = 2.9, ImH), 6.32 (1H, d, *J* = 2.9, ImH), 6.84 (1H, d, *J* = 7.9, ArH), 6.91 (1H, d, *J* = 7.9, ArH), 7.27 (1H, t, *J* = 7.9, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 18.2. 31.2, 55.8, 109.2, 111.8, 111.9, 113.3, 122.4, 125.9, 129.1, 138.0, 155.9. *m*/*z* (CI): 233 (MNH_4^+, 10%), 219 (MH^+, 100), 205 (20). Anal. calcd. for. $C_{12}H_{14}N_2O_2$ (M): 218.105 5; found (M^+): 218.105 4.

*1-(2-Methylphenyl)-3-methylimidazol-2(1**H**)-one (5e)*

1-(2-Methylphenyl)-3-methylimidazol-2(1*H*)-one (**5e**) was prepared as above from 1-phenylimidazol-2(1*H*)-one **3a** (0.18 g, 1.12 mmol) giving 1-(2-methylphenyl)-3-methylimidazol-2(1*H*)-one **5e** as a yellow oil (189 mg, 88%). An analytical sample was prepared by column SiO_2 chromatography (50% EtOAc in hexane). IR ν_{max} (film, cm^{-1}): 1460, 1499, 1686. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.27 (3H, s, $ArCH_3$), 3.35 (3H, s, NCH_3), 6.31 (1H, d, *J* = 2.9, ImH), 6.34 (1H, d, *J* = 2.9, ImH), 7.27 (4H, m, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 17.9, 30.6, 115.6, 112.11, 126.6, 127.4, 128.2, 131.0, 135.5, 137.0, 156.7. *m*/*z* (CI): 236 (MNH_4^+, 76%), 489 (MH^+, 100). Anal. calcd. for. $C_{11}H_{12}N_2O$ (M): 188.094 5; found (M^+): 188.094 8.

*1-(3-Methoxy-2-methylphenyl)-3-methylimidazol-2(1**H**)-one (5h)*

1-(3-Methoxy-2-methylphenyl)-3-methylimidazol-2(1*H*)-one (**5h**) was prepared as above from 1-(3-methoxyphenyl)imidazol-2(1*H*)-one **3c** (0.5 g, 2.6 mmol, 1 equiv.) giving **5h** as a yellow oil (317 mg, 60%). IR ν_{max} (film, cm^{-1}): 1260, 1435, 1476, 1694. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.11 (3H, s, $ArCH_3$), 3.34 (3H, s, NCH_3), 3.86 (3H, s, OCH_3), 6.31 (1H, d, *J* = 3.0, ImH), 6.33 (1H, d, *J* = 3.0, ImH), 6.87 (2H, d, *J* = 8.1, ArH), 7.22 (1H, t, *J* = 8.1, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 11.0, 30.5, 55.7, 109.0, 110.0, 111.7, 112.9, 119.5, 126.5, 126.6, 136.6, 158.4. *m*/*z* (CI): 219 (MH^+, 100%), 102 (30). Anal. calcd. for. $C_{12}H_{14}N_2O_2$ (MH): 219.113 3; found (MH^+): 219.113 7.

*1-(4-Methoxy-2-methylphenyl)-3-methylimidazol-2(1**H**)-one (5i)*

1-(4-Methoxy-2-methylphenyl)-3-methylimidazol-2(1*H*)-one (**5i**) was prepared from 1-(4-methoxyphenyl)imidazol-2(1*H*)-one **3d** (0.2 g, 1.05 mmol) giving **5i** (0.22 g, 96%); an analytical sample was prepared by column SiO_2 chromatography (50% of EtOAc in hexane). IR ν_{max} (film, cm^{-1}): 1242, 1458, 1508, 1677. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.23 (3H, s, $ArCH_3$), 3.35 (3H, s, NCH_3), 3.83 (3H, s, OCH_3), 6.27 (1H, d, *J* = 2.9, ImH), 6.32 (1H, d, *J* = 2.9, ImH), 6.79 (1H, dd, *J* = 8.5, 2.9, ArH), 6.83 (1H, d, *J* = 2.9, ArH), 7.15 (1H, d, *J* = 8.5, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 18.2, 30.6, 55.4, 111.9, 116.0, 128.5, 128.8, 130.7, 137.0, 159.2, 152.7, 166.7. *m*/*z* (CI): 236 (MNH_4^+, 13%), 219 (MH^+, 100). Anal. calcd. for. $C_{12}H_{14}N_2O_2$ (M): 218.105 5; found (M^+): 218.105 4.

4,5-Dihydro-1-(2-methylphenyl)-3-methylimidazol-2(1H)-one (6e)

4,5-Dihydro-1-(2-methylphenyl)-3-methylimidazol-2(1*H*)-one (**6e**) was prepared from 4,5-dihydro-1-phenylimidazol-2(1*H*)-one **4a** (0.162 mg, 1 mmol) giving 4,5-dihydro-1-(2-methylphenyl)-3-methylimidazol-2(1*H*)-one **6e** (64 mg, 34%) as a yellow oil. IR ν_{max} (film, cm^{-1}): 756, 1265, 1400, 1431, 1494, 1701, 2871, 2933. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.30 (3H, s, $ArCH_3$), 2.91 (3H, s, NCH_3), 3.49 (2H, t, *J* = 7.9, ImH), 3.81 (2H, t, *J* = 7.9, ImH), 7.21 (4H, m, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 18.3, 31.9, 42.6, 45.7, 117.5, 126.9, 127.4, 129.0, 131.4, 136.5, 158.4. *m*/*z* (CI): 208 (MH^+, 50%), 191 (MH^+, 100), 177 (20). Anal. calcd. for. $C_{11}H_{14}N_2O$ (M): 190.110 6; found (M^+): 190.110 8.

*4,5-Dihydro-1-(2-methoxy-3-methylphenyl)-3-methylimidazol-2(1**H**)-one (6g) and 4,5-dihydro-1-(2-methoxy-6-methylphenyl)-3-methylimidazol-2(1**H**)-one (6f)*

4,5-Dihydro-1-(2-methoxy-3-methylphenyl)-3-methylimidazol-2(1*H*)-one (**6g**) and 4,5-dihydro-1-(2-methoxy-6-methylphenyl)-3-methylimidazol-2(1*H*)-one (**6f**) were prepared as above from 4,5-dihydro-1-(2-methoxy)phenylimidazol-2(1*H*)-one **4b** (0.4 g, 2.1 mmol) giving from the column firstly **6g** (0.168 g, 37%), then **6f** (0.130 g, 28%) as yellow oils. Spectroscopic data for **6g**: ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.29 (3H, s, $ArCH_3$), 2.90 (3H, s, NCH_3), 3.47 (2H, t, *J* = 7.3, ImH), 3.73 (3H, s, OCH_3), 3.77 (2H, t, *J* = 7.3, ImH), 7.04 (2H, m, ArH), 7.23 (1H, m, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 15.8, 31.4, 44.5, 45.5, 59.9, 123.9, 124.0, 125.6, 128.8, 131.9, 154.0, 159.9. *m*/*z* (CI): 221 (M^+,100%). Anal. calcd. for. $C_{12}H_{16}N_2O_2$ (M): 206.121 2; found (M^+): 220.121 4. Spectroscopic data for **6f**: ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.17 (3H, s, $ArCH_3$), 2.73 (3H, s, NCH_3), 3.42 (2H, m, ImH), 3.62 (2H, m, ImH), 3.76 (3H, s, OCH_3) 6.85 (1H, apparent d, *J* = 8.0, ArH), 6.90 (1H, apparent d, *J* = 8.0, ArH), 7.20 (1H, apparent t, *J* = 8.0, Ar). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 17.6, 31.6, 44.6, 45.8, 55.7, 109.2, 122.5, 128.1, 129.0, 139.2, 156.7, 160.1. *m*/*z* (CI): 221 (MH^+, 100%), 207 (70). Anal. calcd. for. $C_{12}H_{16}N_2O_2$ (M): 206.121 2; found (M^+): 220.121 4.

4,5-Dihydro-1-(3-methoxy-2-methylphenyl)-3-methylimidazolidin-2-one (6h)

4,5-Dihydro-1-(3-methoxy-2-methylphenyl)-3-methylimidazolidin-2-one (**6h**) was prepared as above from 4,5-dihydro-1-(3-methoxyphenyl)imidazol-2(1*H*)-one **4c** (0.1 g, 5.2 mmol) giving **6h** (0.08 g, 22%) as a yellow oil. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.16 (3H, s, $ArCH_3$), 2.92 (3H, s, NCH_3), 3.51 (2H, t, *J* = 7.9, ImH), 3.68 (2H, t, *J* = 7.9,

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ImH), 3.87 (3H, s, OCH_3), 6.80 (1H, d, J = 7.9, ArH), 6.85 (1H, d, J = 7.9, ArH), 7.19 (1H, t, J = 7.9, ArH). ^{13}C NMR (75 MHz, $CDCl_3$): 10.9, 31.5, 42.3, 42.5, 55.2, 103.1, 108.8, 118.7, 125.2, 129.3, 141.9, 159.9. *m/z* (CI): 221 (M^+, 100%), 207 (87). Anal. calcd. for. $C_{12}H_{16}N_2O_2$ (M): 220.121 2; found (M^+): 220.121 0.

4,5-Dihydro-1-(4-methoxy-2-methylphenyl)-3-methylimidazol-2(1H)-one (6i) and 4,5-dihydro-1-(4-methoxy-3-methylphenyl)-3-methylimidazol-2(1H)-one (6j)

4,5-Dihydro-1-(4-methoxy-2-methylphenyl)-3-methylimidazol-2(1*H*)-one (**6i**) and 4,5-dihydro-1-(4-methoxy-3-methylphenyl)-3-methylimidazol-2(1*H*)-one (**6j**) were prepared from 4,5-dihydro-1-(4-methoxyphenyl)imidazol-2(1*H*)-one **4d** (30 mg, 0.16 mmol) giving firstly from the column **6i** (3 mg, 9%) as a foamy yellow solid, and secondly, **6j** (4 mg, 12%) as a yellow oil. Spectroscopic data for **6i**: IR ν_{max} (film, cm^{-1}): 1030, 1106, 1244, 1400, 1433, 1505, 1700, 2923. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.22 (3H, s, $ArCH_3$), 2.90 (3H, s, NCH_3), 3.45 (2H, apparent t, J = 7.9, ImH), 3.75 (2H, apparent t, J = 7.9, ImH), 3.80 (3H, s, OMe), 6.80 (1H, d, J = 7.7, ArH), 7.25 (1H, s, ArH), 7.57 (1H, m, ArH). *m/z* (CI): 238 (MNH_4^+, 20%), 221 (MH^+, 100). Anal. calcd. for $C_{12}H_{16}N_2O_2$ (M): 220.121 2; found (M^+): 220.121 6. Spectroscopic data for **6j**: IR ν_{max} (film, cm^{-1}): 1046, 1097, 1241, 1401, 1433, 1505, 1698, 3424. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 2.30 (3H, s, $ArCH_3$), 2.80 (3H, s, NCH_3), 3.48 (2H, t, J = 7.9, ImH), 3.65 (2H, t, J = 7.9, ImH), 3.82 (3H, s, OMe), 6.76 (1H, m, ArH), 6.80 (1H, m, ArH), 7.12 (1H, d, J = 7.8, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 18.4, 31.9, 46.8, 46.0, 55.7, 112.4, 116.4, 128.5, 131.7, 138.1, 146.8, 158.7. *m/z* (CI): 238 (MNH_4^+, 20%), 221 (MH^+, 100). Anal. calcd. for. $C_{12}H_{16}N_2O_2$ (M): 220.121 2; found (M^+): 220.121 1.

Typical procedure for lithiation of imidazolones (3a–3d) with 2.5 equiv. *n*-BuLi and then reaction with phenyl isocyanate

These experiments followed exactly the method described previously for trapping with iodomethane, but used phenyl isocyanate as the electrophile.

1-Phenyl-3-(phenylaminocarbonyl)imidazol-2(1H)-one (9a) and 3-(phenylaminocarbonyl)-1-[(2-phenylaminocarbonyl)phenyl]imidazol-2(1H)-one (9b)

1-Phenyl-3-(phenylaminocarbonyl)imidazol-2(1*H*)-one (**9a**) and 3-(phenylaminocarbonyl)-1-[(2-phenylaminocarbonyl)phenyl]imidazol-2(1*H*)-one (**9b**) were made from 1-phenylimidazol-2(1*H*)-one **3a** (0.2 g, 1.25 mmol) with *n*-BuLi (1.6 mol L^{-1}, 1.95 mL, 2.5 equiv.), then phenyl isocyanate (0.34 mL, 3.12 mmol, 2.5 equiv.) was added giving from chromatography firstly **9a** as a yellow solid (12 mg, 3%), mp 122 °C, lit. value (18) mp 123 °C, and secondly, **9b** as a white solid (300 mg, 86%), mp 150 °C. Spectroscopic data for **9a**: IR ν_{max} (film, cm^{-1}): 755, 1077, 1236, 1259, 1412, 1502, 1555, 1598, 1690, 1730. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 6.81 (1H, d, J = 3.2, ImH), 7.20 (1H, m, ArH), 7.28 (1H, d, J = 3.2, ImH), 7.40 (4H, m, ArH), 7.59 (5H, m, ArH), 10.91 (1H, bs, NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 108.6, 111.7, 120.0, 122.4, 124.4, 127.1, 129.0, 129.4, 136.9, 147.3, 150.3, 162.7. *m/z* (CI): 297 (MNH_4^+, 20%), 280 (MH^+, 100). Anal. calcd. for. $C_{16}H_{13}N_3O_2$ (M): 279.100 8; found (M^+): 279.100 5. Spectroscopic data for **9b**: IR ν_{max} (film, cm^{-1}): 754, 1234, 1320, 1411, 1443, 1495, 1553, 1601, 1678, 1730. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 6.59 (1H, d, J = 3.2, ImH,), 7.12 (2H, m, ArH), 7.22 (1H, d, J = 3.2, ImH), 7.35 (5H, m, ArH), 7.58 (6H, m, ArH), 7.79 (1H, d, J = 7.3, ArH), 8.49 (1H, bs, NH), 10.65 (1H, bs, NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 109.1, 113.9, 119.9, 120.1, 124.5, 124.7, 127.7, 128.3, 129.0, 129.3, 129.4, 131.5, 132.0, 135.0, 136.7, 137.6, 146.7, 151.4, 164.7. *m/z* (CI): 416 (MNH_4^+, 5%), 399 (MH^+, 8), 297 (20), 280 (100). Anal. calcd. for. $C_{23}H_{18}N_4O_3$ (M): 398.137 9; found (M^+): 398.137 5.

3-(Phenylaminocarbonyl)-1-[6-methoxy-2-(phenylaminocarbonyl)phenyl]imidazol-2(1H)-one (9c) and 3-(phenylaminocarbonyl)-1-[2-methoxy-3-(phenylaminocarbonyl)phenyl]-imidazol-2(1H)-one (9d)

3-(Phenylaminocarbonyl)-1-[6-methoxy-2-(phenylaminocarbonyl)phenyl]imidazol-2(1*H*)-one (**9c**) and 3-(phenylaminocarbonyl)-1-[2-methoxy-3-(phenylaminocarbonyl)phenyl]imidazol-2(1*H*)-one (**9d**) were made from a solution of 1-(2-methoxyphenyl)imidazol-2(1*H*)-one **3b** (0.23 g, 1.2 mmol) with *n*-BuLi (1.6 mol L^{-1}, 1.95 mL, 2.5 equiv.), then phenyl isocyanate (0.34 mL, 3.12 mmol, 2.5 equiv.) was added giving firstly from chromatography **9c** (80 mg, 15%, slightly contaminated by a phenyl isocyanate derivative), and secondly, **9d** (97 mg, 18%) as low mp yellow solids. Spectroscopic data for **9c**: IR ν_{max} (film, cm^{-1}): 754, 1055, 1233, 1409, 1440, 1492, 1550, 1599, 1680, 1707, 1728. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.85 (3H, s, OCH_3), 6.42 (1H, d, J = 3.2, ImH), 7.01–7.81 (14H, m, ArH + ImH), 8.54 (1H, s, NH), 10.63 (1H, s, NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 56.4, 102.9, 108.7, 113.9, 115.4, 120.0, 120.4, 120.7, 124.8, 124.9, 126.6, 128.6, 129.0, 129.3, 131.4, 138.0, 156.0, 163.3, 164.8. *m/z* (CI): 446 (MNH_4^+, 25%), 429 (MH^+, 40), 310 (100). Anal. calcd. for. $C_{24}H_{20}N_4O_4$ (M): 428.148 4; found (M^+): 428.149 3. Spectroscopic data for **9d**: IR ν_{max} (film, cm^{-1}): 753, 1441, 1598, 1710, 3329. ^{1}H NMR (300 MHz, $CDCl_3$) δ: 3.75 (3H, s, OCH_3), 6.24 (1H, bs, ImH), 6.30 (1H, bs, ImH), 7.03 (3H, m, ArH), 7.21 (4H, apparent t, J = 8.0, ArH), 7.29 (2H, apparent d, J = 7.7, ArH), 7.43 (2H, t, J = 8.0, ArH), 7.60 (2H, d, J = 7.7, ArH), 9.60 (1H, s, NH), 9.97 (1H, s, NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 56.3, 109.4, 113.6, 115.0, 115.5, 120.2, 120.6, 121.1, 122.5, 124.5, 128.1, 129.1, 130.9, 131.9, 138.5, 138.7, 142.2, 154.8, 156.0, 165.3. *m/z* (CI): 446 (MNH_4^+, 2%), 429 (MH^+, 4), 327 (8), 310 (100), 217 (5), 102 (5). Anal. calcd. for. $C_{24}H_{20}N_4O_4$ (M): 428.148 4; found (M^+): 428.149 2.

1-[(3-Methoxy-2-phenylaminocarbonyl)phenyl]-3-phenylaminocarbonylimidazol-2(1H)-one (9e) and 1-(3-methoxyphenyl)-3-(phenylaminocarbonyl)imidazol-2(1H)-one (9f)

1-[(3-Methoxy-2-phenylaminocarbonyl)phenyl]-3-phenylaminocarbonylimidazol-2(1*H*)-one (**9e**) and 1-(3-methoxyphenyl)-3-(phenylaminocarbonyl)imidazol-2(1*H*)-one (**9f**) were made from 1-(3-methoxyphenyl)imidazol-2(1*H*)-one **3c** (0.27 g, 1.42 mmol) with *n*-BuLi (1.6 mol L^{-1}, 2.2 mL, 2.5 equiv.) then phenyl isocyanate (0.39 mL, 3.5 mmol, 2.5 equiv.) giving from chromatography firstly **9e** as a white solid (160 mg, 36%), mp 101 °C, and secondly, **9f** as a white solid (95 mg, 21%), mp 180 °C. Spectroscopic data for **9e**:

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IR ν_{max} (film, cm^{-1}): 735, 1233, 1410, 1440, 1474, 1554, 1601, 1679, 1729. ^1H NMR (300 MHz, $CDCl_3$) δ: 3.91 (3H, s, OCH_3), 6.60 (1H, d, *J* = 3.3, ImH), 7.03 (2H, t, *J* = 7.8, ArH), 7.12 (1H, d, *J* = 3.3, ImH), 7.14 (2H, m, ArH), 7.33 (4H, m, ArH), 7.52 (3H, m, ArH), 7.58 (2H, apparent d, *J* = 8.4, ArH), 8.41 (1H, s, NH), 10.73 (1H, s, NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 56.3, 108.5, 111.9, 113.9, 119.6, 119.9, 120.1, 124.4, 124.6, 128.9, 129.0, 131.4, 133.0, 133.4, 136.8, 137.6, 146.9, 151.3, 157.2, 162.4. *m/z* (CI): 429 (MH^+, 3%), 310 (12), 217 (100), 119 (10). Anal. calcd. for. $C_{24}H_{20}N_4O_4$ (M): 428.148 4; found (M^+): 428.148 5. Spectroscopic data for **9f**: IR ν_{max} (film, cm^{-1}): 758, 1263, 1441, 1474, 1597, 1680. ^1H NMR (300 MHz, $CDCl_3$) δ: 3.94 (3H, s, OCH_3), 6.47 (1H, d, *J* = 3.0, ImH), 6.58 (1H, d, *J* = 3.0, ImH), 7.07 (1H, m, ArH), 7.13 (1H, m, ArH), 7.21 (2H, d, *J* = 8.1, ArH), 7.32 (2H, m, ArH), 7.55 (3H, apparent t, *J* = 8.1, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 55.3, 108.9, 111.0, 113.6, 119.5, 119.9, 124.0, 124.1, 125.0, 128.3, 130.6, 132.1, 138.2, 156.0, 157.2. *m/z* (CI): 310 (MH^+, 35%), 217 (100). Anal. calcd. for. $C_{17}H_{15}N_3O_3$ (M): 309.1113; found (M^+): 309.110 9.

1-(4-Methoxyphenyl)-3-(phenylaminocarbonyl)imidazol-2(1H)-one (9g) and 1-[(4-methoxy-2-phenylaminocarbonyl)phenyl]-3-phenylaminocarbonylimidazol-2(1H)-one (9h)

1-(4-Methoxyphenyl)-3-(phenylaminocarbonyl)imidazol-2(1*H*)-one (**9g**) and 1-[(4-methoxy-2-phenylaminocarbonyl)phenyl]-3-phenylaminocarbonylimidazol-2(1*H*)-one (**9h**) were made from 1-(4-methoxyphenyl)imidazol-2(1*H*)-one **3d** (0.24 g, 1.25 mmol) with *n*-BuLi (1.6 mol L^{-1}, 1.95 mL, 2.5 equiv.), then phenyl isocyanate (0.34 mL, 3.12 mmol, 2.5 equiv) was added giving from chromatography firstly **9g** as a white foam (20 mg, 6.5%), and secondly, **9h** as a white solid (0.091 g, 30%), mp 167–169 °C. Spectroscopic data for **9g**: ^1H NMR (300 MHz, $CDCl_3$) δ: 3.77 (3H, s, OCH_3), 6.52 (1H, d, *J* = 3.2, ImH), 6.92 (2H, m, ArH), 7.06 (1H, m, ArH), 7.13 (1H, d, *J* = 3.2, ImH), 7.28 (2H, m, ArH), 7.35 (2H, m, ArH), 7.49 (2H, m, ArH), 10.61 (1H, bs, NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 55.9, 108.6, 112.6, 114.9, 120.3, 120.9, 124.6, 124.7, 129.3, 130.7, 137.3, 156.0, 158.9. *m/z* (CI): 310 (MH^+, 100%), 191 (70), 94 (25). Anal. calcd. for. $C_{17}H_{15}N_3O_3$ (M): 309.113 3; found (M^+): 309.113 1. Spectroscopic data for **9h**: ^1H NMR (300 MHz, $CDCl_3$) δ: 3.92 (3H, s, OCH_3), 6.54 (1H, d, *J* = 3.2, ImH), 7.14 (2H, m, ArH), 7.17 (1H, d, *J* = 3.2, ImH), 7.31 (4H, m, ArH), 7.39 (3H, apt, *J* = 7.4, ArH), 7.56 (4H, m, ArH), 8.61 (1H, bs, NH), 10.70 (1H, bs, NH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 55.8, 108.7, 110.0, 114.0, 114.4, 117.3, 119.8, 120.1, 124.5, 124.6, 124.7, 129.0, 129.4, 136.5, 137.4, 137.9, 146.7, 152.0, 160.1, 164.5. *m/z* (CI): 429 (MH^+, 5%), 310 (100), 217 (14), 119 (14). Anal. calcd. for. $C_{24}H_{20}N_4O_4$ (M): 428.148 4; found (M^+): 428.149 6.

Typical procedure for the reaction of 1-aryl-3-methylimidazolones (5a–5d) with 1 equiv. of *n*-BuLi and trapping with iodomethane

1-Phenyl-3,5-dimethylimidazol-2(1H)-one (5j) 1-phenyl-3,4-dimethylimidazol-2(1H)-one (5k)

A solution of 3-methyl-1-phenyl-imidazol-2(1*H*)-one **5a** (0.2 g, 1.15 mmol, 1 equiv.) in anhyd. THF was treated with *n*-BuLi (1.6 mol L^{-1}, 0.79 mL, 1.1 equiv.) at –78 °C over 30 min under N_2. The solution was warmed up to then maintained at 0 °C for 2 h and cooled down to –78 °C again for the addition of iodomethane (0.1 mL, 1.72 mmol, 1.5 equiv.). The reaction mixture was allowed to warm up to rt and after 20 h quenched with satd. aq. NH_4Cl, and evaporated to remove the THF. The white organic residue was taken up with CH_2Cl_2, the solution washed with brine, dried over $MgSO_4$ and evaporated. Column SiO_2 chromatography (50%–70%–100% of EtOAc in hexane) yielded firstly 1-(2-methylphenyl)-3,5-dimethylimidazol-2(1*H*)-one **5j** (28 mg, 12%) as a low mp solid, and secondly, 1-(2-methylphenyl)-3,4-methylimidazol-2(1*H*)-one **5k** (96 mg, 46%) as a solid mp 130 °C. Spectroscopic data for **5j**: IR ν_{max} (film, cm^{-1}): 1401, 1500, 1638, 1655, 1676, 1685. ^1H NMR (300 MHz, $CDCl_3$) δ: 1.84 (3H, s, $ImCH_3$), 3.19 (3H, s, NCH_3), 5.94 (1H, bs, ImH), 7.21 (2H, m, ArH), 7.28 (1H, apparent d, *J* = 7.2, ArH), 7.37 (1H, apparent t, *J* = 7.2, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 10.9, 30.1, 108.5, 118.5, 127.3, 127.5, 129.0, 134.7, 152.7. *m/z* (CI): 206 (MNH_4^+, 15%), 189 (MH^+, 100). Anal. calcd. for. $C_{11}H_{12}N_2O$ (M): 188.095 0; found (M^+): 188.094 9. Spectroscopic data for **5k**: IR ν_{max} (film, cm^{-1}): 760, 1400, 1430, 1455, 1503, 1595, 1639, 1680, 1717. ^1H NMR (300 MHz, $CDCl_3$) δ: 2.11 (3H, s, $ImCH_3$), 3.26 (3H, s, NCH_3), 6.33 (1H, bs, ImH), 7.21 (1H, m, ArH), 7.41 (1H, apparent t, *J* = 7.5, ArH), 7.37 (1H, apparent t, *J* = 7.5, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 10.2, 27.1, 104.9, 120.2, 121.1, 125.1, 125.6, 128.9, 137.3, 153.3. *m/z* (CI): 206 (MNH_4^+, 20%), 189 (MH^+, 100), 175 (42). Anal. calcd. for. $C_{11}H_{12}N_2O$ (M): 188.095 0; found (M^+): 188.094 8.

1-(2-Methoxyphenyl)-3,5-dimethylimidazol-2(1H)-one (5l) and 1-(2-methoxyphenyl)-3,4-dimethylimidazol-2(1H)-one (5m)

1-(2-Methoxyphenyl)-3,5-dimethylimidazol-2(1*H*)-one (**5l**) and 1-(2-methoxyphenyl)-3,4-dimethylimidazol-2(1*H*)-one (**5m**) were prepared from 1-(2-methoxyphenyl)-3-methylimidazol-2(1*H*)-one **5b** (0.25 g, 1.2 mmol) with *n*-BuLi (1.6 mol L^{-1}, 1.3 mL, 1.5 equiv.), then iodomethane (0.15 mL, 2.4 mmol, 2 equiv.) was added giving from chromatography a mixture (129 mg) (Anal. calcd. for $C_{12}H_{14}N_2O_2$ (M): 218.105 5; found (M^+): 218.204 9) of **5l** (12%, estimated by ^1H NMR) and its isomer **5m** (36%, estimated by ^1H NMR) as yellow oils. Spectroscopic data for **5l**: ^1H NMR (300 MHz, $CDCl_3$) δ: 2.20 (3H, s, $ImCH_3$), 3.30 (3H, s, NCH_3), 3.81 (3H, s, OCH_3), 5.95 (1H, bs, ImH), 6.86–7.50 (4H, m, ArH). *m/z* (CI): 233 (MNH_4^+, 51%), 219 (MH^+, 100). Spectroscopic data for **5m**: ^1H NMR (300 MHz, $CDCl_3$) δ: 2.12 (3H, bs, $ImCH_3$), 3.28 (3H, s, NCH_3), 3.87 (3H, s, OCH_3), 6.21 (1H, s, ImH), 7.01–7.50 (4H, m, ArH). *m/z* (CI): 233 (MNH_4^+, 51%), 219 (MH^+, 100).

1-(4-Methoxyphenyl)-3,4-dimethylimidazol-2(1H)-one (5n) and 1-(4-methoxyphenyl)-3,5-dimethylimidazol-2(1H)-one (5o)

1-(4-Methoxyphenyl)-3,4-dimethylimidazol-2(1*H*)-one **5n** and 1-(4-methoxyphenyl)-3,5-dimethylimidazol-2(1*H*)-one **5o** were prepared from 1-(4-methoxyphenyl)-3-methylimidazol-2(1*H*)-one **5d** (0.2 g, 0.98 mmol) with *n*-BuLi (1.6 mol L^{-1}, 0.67 mL, 1.1 equiv.), then iodomethane

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(0.09 mL, 1.47 mmol, 1.5 equiv.) was added giving from chromatography firstly **5n** as yellow oil (104 mg, 49%), and secondly, **5o** as a yellow solid, mp 118–120 °C (33 mg, 16%). Spectroscopic data for **5n**: IR ν_{max} (film, cm^{-1}): 1251, 1516, 1678. ^1H NMR (300 MHz, $CDCl_3$) δ: 2.12 (3H, s, $ImCH_3$), 3.27 (3H, s, NCH_3), 3.83 (3H, s, OCH_3), 6.26 (1H, bs, ImH), 6.94 (2H, d, J = 9.1, ArH), 7.48 (2H, d, J = 9.1, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 10.1, 30.4, 55.4, 105.5, 109.7, 112.2, 114.2, 123.0, 130.7, 157.1. *m/z* (CI): 236 (MNH_4^+, 10%), 219 (MH^+, 100), 205 (90). Anal. calcd. for $C_{12}H_{14}N_2O_2$ (M): 218.105 5; found (M^+): 218.105 6. Spectroscopic data for **5o**: IR ν_{max} (film, cm^{-1}): 1248, 1402, 1461, 1514, 1638, 1684, 2361. ^1H NMR (300 MHz, $CDCl_3$) δ: 1.91 (3H, s, $ImCH_3$), 3.30 (3H, s, NCH_3), 3.85 (3H, s, OCH_3), 6.02 (1H, bs, ImH), 6.98 (2H, d, J = 8.9, ArH), 7.22 (2H, d, J = 8.9, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 10.8, 30.1, 55.0, 108.1, 114.4, 118.9, 127.9, 128.7, 153.3, 158.9. *m/z* (CI): 236 (MNH_4^+,10%), 219 (MH^+, 100). Anal. calcd. for $C_{12}H_{14}N_2O_2$ (M): 218.105 5; found (M^+): 218.105 2.

Typical procedure for dilithiation of (5a–5d) with 2.5 equiv. *n*-BuLi and trapping with iodomethane

*1-(2-Methylphenyl)-3,4-dimethylimidazol-2(1*H*)-one (5p)*

A solution of 3-methyl-1-phenylimidazol-2(1*H*)-one **5a** (0.1 g, 0.57 mmol) in anhyd. THF was treated with *n*-BuLi (1.6 mol L^{-1}, 0.89 mL, 2.5 equiv.) at –78 °C over 30 min under N_2. The solution was warmed up to then maintained at 0 °C for 2 h and cooled down to –78 °C again for the addition of iodomethane (0.09 mL, 1.43 mmol, 2.5 equiv.). The reaction mixture was allowed to warm up to rt and after 20 h quenched with satd. aq. NH_4Cl, and evaporated to remove the THF. The organic residue was taken up with CH_2Cl_2, the solution washed with brine, dried over $MgSO_4$, and evaporated to give the title compound **5p** as a yellow oil (109 mg, 95%). IR ν_{max} (film, cm^{-1}): 716, 757, 1401, 1432, 1463, 1497, 1689, 1718, 2922. ^1H NMR (300 MHz, $CDCl_3$) δ: 2.15 (3H, s, $ImCH_3$), 2.30 (3H, s, $ArCH_3$), 3.30 (3H, s, NCH_3), 6.07(1H, s, ImH), 7.25 (4H, m, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 10.6, 18.4, 27.7, 107.8, 119.8, 126.8, 127.7, 128.3, 129.3, 131.3, 135.7, 152.6. *m/z* (CI): 220 (MNH_4^+, 37%), 203 (MH^+, 100). Anal. calcd. for $C_{12}H_{14}N_2O$ (M): 202.110 6; found (M^+): 202.110 2.

*1-(2-Methoxy-6-methylphenyl)-3,4-dimethylimidazol-2(1*H*)-one (5q)*

1-(2-Methoxy-6-methylphenyl)-3,4-dimethylimidazol-2(1*H*)-one **5q** was prepared from 1-(2-methoxyphenyl)-3-methylimidazol-2(1*H*)-one **5b** (0.1 g, 0.49 mmol) with *n*-BuLi (1.6 mol L^{-1}, 0.76 mL, 2.5 equiv.), then iodomethane (0.08 mL, 1.22 mmol, 2.5 equiv.) was added giving **5q** as a yellow oil (0.1 g, 88%). IR ν_{max} (film, cm^{-1}): 776, 1080, 1271, 1399, 1433, 1464, 1475, 1495, 1687, 2928. ^1H NMR (300 MHz, $CDCl_3$) δ: 2.11 (3H, s, $ImCH_3$), 2.17 (3H, s, $ArCH_3$), 3.29 (3H, s, NCH_3), 3.78 (3H, s, OCH_3), 5.97 (1H, s, ImH), 6.80 (1H, d, J = 8.0, ArH), 6.87 (1H, d, J = 8.0, ArH), 7.23 (1H, t, J = 8.0, ArH). ^{13}C NMR (75 MHz, $(CD_3)_2CO$) δ: 9.7, 17.5, 30.0, 55.5, 107.8, 109.6, 112.5, 119.2, 120.7, 122.3, 128.9, 134.4, 156.4. *m/z* (CI): 250 (MNH_4^+18, 4%), 232 (MH^+, 100), 219 (30). Anal. calcd. for $C_{13}H_{16}N_2O_2$ (M): 232.121 2; found (M^+): 232.121 5.

*1-(3-Methoxy-2-methylphenyl)-3,4-dimethylimidazol-2(1*H*)-one (5r)*

1-(3-Methoxy-2-methylphenyl)-3,4-dimethylimidazol-2(1*H*)-one **5r** was prepared from 1-(3-methoxyphenyl)-3-methylimidazol-2(1*H*)-one **5c** (0.17 g, 0.83 mmol) with *n*-BuLi (1.6 mol L^{-1}, 1.3 mL, 2.5 equiv.), then iodomethane (0.09 mL, 1.5 mmol, 1.9 equiv.) was added giving **5r** as a clear oil (0.43 mg, 24%). IR ν_{max} (film, cm^{-1}): 1140, 1261, 1402, 1433, 1475, 1589, 1638, 1686. ^1H NMR (300 MHz, $CDCl_3$) δ: 2.11 (3H, s, $ArCH_3$), 2.12 (3H, bs, $ImCH_3$), 3.28 (3H, s, NCH_3), 3.86 (3H, s, OCH_3), 6.04 (1H, bs, ImH), 6.86 (2H, d, J = 8.1, ArH), 7.20 (1H, t, J = 8.1, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 10.3, 11.1, 27.3, 55.6, 107.6, 109.5, 119.35, 119.5, 124.6, 126.4, 136.7, 152.5, 158.4. *m/z* (CI): 250 (MNH_4^+, 7%), 233 (MH^+, 100), 219 (25). Anal. calcd. for $C_{13}H_{16}N_2O_2$ (M): 232.121 2; found (M^+): 232.121 0.

*1-(4-Methoxy-2-methylphenyl)-3,4-dimethylimidazol-2(1*H*)-one (5s)*

1-(4-Methoxy-2-methylphenyl)-3,4-dimethylimidazol-2(1*H*)-one **5s** was prepared from 1-(4-methoxyphenyl)-3-methylimidazol-2(1*H*)-one **5d** (0.1 g, 0.49 mmol, 1 equiv.) with *n*-BuLi (1.6 mol L^{-1}, 0.76 mL, 2.5 equiv.), then iodomethane (0.076 mL, 1.22 mmol, 2.5 equiv.) was added giving **5s** as a yellow oil (0.107 g, 97%). IR ν_{max} (film, cm^{-1}): 1044, 1096, 1161, 1252, 1401, 1432, 1463, 1508, 1686, 2932. ^1H NMR (300 MHz, $CDCl_3$) δ: 2.11 (3H, s, $ArCH_3$), 2.18 (3H, s, $ArCH_3$), 3.28 (3H, s, NCH_3), 3.81 (3H, s, OCH_3), 6.01 (1H, s, ImH), 6.80 (2H, m, ArH), 7.12 (1H, d, J = 8.6, ArH). ^{13}C NMR (75 MHz, $CDCl_3$) δ: 10.6, 18.5, 27.7, 55.7, 108.0, 112.0, 116.2, 119.4, 128.7, 129.1, 137.2, 142.2, 159.2. *m/z* (CI): 250 (MNH_4^+, 26%), 233 (MH^+, 100), 146.2, 164.5. *m/z* (CI): 163 (MH^+, 100%). Anal. calcd. for $C_{13}H_{16}N_2O_2$ (M): 232.121 2; found (M^+): 232.121 7.

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